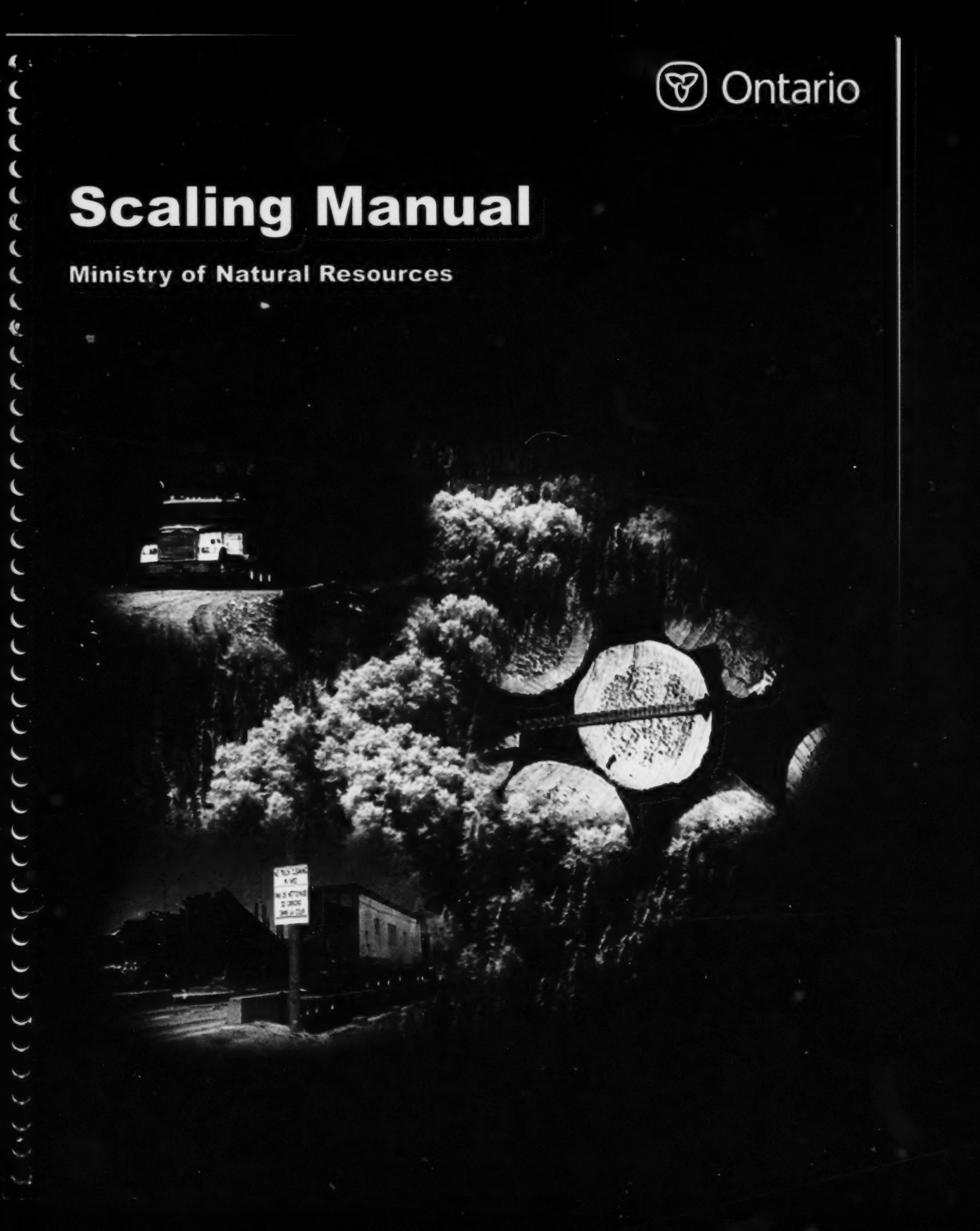
Ontario

Scaling Manual

Ministry of Natural Resources



SCALING MANUAL

Ministry of Natural Resources

Prepared under the Authority of
The Crown Forest Sustainability Act

Third Edition

April 1, 2007

Ontario

Cette publication est également disponible en francais

Printed on recycled paper

Nine Editions of the Manual of Scaling Instructions were previously authorized under the *Crown Timber Act*.
This is the third edition under the *Crown Forest Sustainability Act*.

This Manual is dedicated to the memory of

John Harold Bingley - Scaler's Licence # 1419

Clarence Lajeunesse - Scaler's Licence # 3786

Carl (Harvey) MacIntosh - Scaler's Licence # 815

Frank Zapora - Scaler's Licence # 4152

for their many years of service in the

Provincial Wood Measurement Program.

FOREWORD

The *Policy Framework for Sustainable Forests*

The overall context for forest management in Ontario is the Policy Framework for Sustainable Forests which was approved by the Government in 1993. The framework sets broad direction for forest policy and makes forest sustainability the primary objective of forest management. Its legislative authority is found in the *Crown Forest Sustainability Act (CFSA).*

Overview of the *Crown Forest Sustainability Act*

The CFSA was passed by the Ontario Legislature on December 7, 1994. The CFSA is enabling legislation and provides for the regulation of forest planning, information, operations, licensing, trust funds, processing facilities, remedies and enforcement, and transitional provisions. The CFSA is designed to allow for the management of all forest based values.

A Manual Approach to CFSA Implementation

The CFSA requires the provision of four manuals to guide various aspects of forest management in Ontario. These manuals are authorized by Section (68) of the Act and form part of the regulations as per Section (69(29)).

The four manuals are:

1. The *Forest Management Planning Manual*
2. The *Forest Operations and Silviculture Manual*
3. The *Scaling Manual*
4. The *Forest Information Manual*

The *Forest Management Planning Manual* is the pivotal document which provides direction for all aspects of forest management on Crown lands in Ontario. Forest management plans provide the authority to carry out activities including road construction, timber harvesting, forest renewal and protection treatments, wildlife habitat management, sensitive values protection, surveys and evaluations.

The *Forest Operations and Silviculture Manual* is a compendium of guidance and direction for the conduct of operations authorized by approved forest management plans. This Manual provides for the qualification of persons engaged in forest operations as well as measures for assessing the performance of forest operations.

The *Scaling Manual* provides direction for the measurement of Crown forest resources in Ontario. This measurement provides the means through which Ontario collects revenue from the disposition of Crown forest resources.

The *Forest Information Manual* provides guidance for information management that supports forest management planning and operations. Much of its content has been set by planning and operational information requirements.

The CFSA defines sustainability as long term Crown forest health. The subject of sustainability is addressed in the *Forest Management Planning Manual*. Related information and operational direction are contained in the *Forest Information Manual* and *Forest Operations and Silviculture Manual*.

Manual Revision

These manuals will always be works in progress. They will be revised and updated to reflect the many changes that lie ahead. Revisions to these manuals will be made through consultation with non-government organizations and the Provincial Policy and Technical Committees.

TABLE OF CONTENTS

LIST OF FIGURES

I – INTRODUCTION

The Scaling Manual is authorized under Section 68(1) of the *Crown Forest Sustainability Act* (CFSA) and defines the methods of fulfilling the Ministry's scaling requirements.

This Manual provides standard instructions for the authorized movement and determination of quantity and quality (measurement) for Crown forest resources harvested in Ontario.

The Manual also defines standards for the training, licensing and approval of scalers and scaling auditors in Ontario. It sets out the obligations of persons holding forest resource licences or receiving Crown forest resources, for the keeping of records, the completion of returns to the Ministry and other matters concerned with the measurement of Crown forest resources.

II – PRINCIPLES OF WOOD MEASUREMENT

The scaling of Crown forest resources is the measurement of harvested Crown forest resources and the determination of defects that affect their use. There are several methods of scaling which are approved for use in Ontario. They are cube scaling, tree length scaling, stack scaling, cube scaling by grade, mass measuring and standing tree.

The standing tree method may only be used where approved under certain conditions as defined in this Manual.

Grading of white and red pine may be applied for the purpose of determining stumpage values. Grading will be done according to procedures set by the Minister under the authority of Section 45(3) of the CFSA.

Hard maple and soft maple may be separated for the purpose of determining stumpage values. Species determination will be done according to procedures set by the Minister (Section 45(3) of the CFSA).

The proper calculation of harvested volumes, their destination and the application of the Ontario Crown Timber Charges tables results in the accurate determination of Crown charges. A portion of the charges fund the renewal of the Crown forest.

To account for the defects determined by scaling, either the volume or the stumpage value of Crown forest resources harvested may be reduced. When volume reduction is used, scaling returns are made in net volumes; when value reduction is used as in grade scaling, returns are made in gross volumes by grade.

If deductions are being made for undersize material, this deduction must be made before any defect deduction is applied. Defect deductions are applied only to merchantable material. There are no deductions for defect in undersize material.

Crown forest resources may not be removed from the place of harvesting until they have been measured by a Ministry approved licensed scaler (Section 45(1) of the CFSA) or the removal has been authorized in writing by the **Minister** (Section 45(3) of the CFSA).

Scalers must measure Crown forest resources according to the instructions in this Manual. They must be able to identify species, recognize defects and make only such deductions as authorized in this Manual. Scalers must provide true and accurate information and must not vary from the prescribed methods of measurement.

All sound or merchantable Crown forest resources, regardless of size or species **must be** measured and recorded. Only deductions defined by this Manual shall be shown on scale records returned to the Ministry.

The cubic metre is the recognized unit of timber measurement in Ontario. However, a cubic metre of timber does not always yield a consistent volume of manufactured product. This may be due to different machinery, manufacturing processes or skill of operating personnel. Variations are to be expected and **the scaler must not alter scaling practices to adjust for them**.

When marking timber that has been scaled, the colours black and red are reserved for Crown purposes. No operator, individual or scaler who is not authorized or employed to measure timber for the Ministry may use these colours.

The following principles of rounding will apply in wood measurement; for example, when rounding to three decimal places:

- If the last digit is less than 5, the third digit to the right of the decimal place remains the same.

  Example: 3.2343 = 3.234

- If the last digit is greater than 5, the third digit to the right of the decimal place is raised to the next highest digit.

  Example: 3.2346 = 3.235

- If the last digit is 5, preceded by an even number, the third digit to the right of the decimal place remains the same.

  Example: 3.2345 = 3.234

- If the last digit is 5, preceded by an odd number, the third digit to the right of the decimal place is raised to the next highest digit.

  Example: 3.2355 = 3.236

These principles also apply when rounding to two decimal places.

III – METHODS OF WOOD MEASUREMENT

A. CUBIC METHOD

All conifer, poplar and white birch of any length may be measured by this method.

1. UNIT OF MEASUREMENT

Cubic metre

2. MEASURING PROCEDURE

(a) Diameters

Diameters are measured **inside the bark** in **2 centimetre size class** intervals, with the **class boundary occurring on the odd centimetre**, and recorded in **even centimetre classes**. **A scaled log that coincides with the class boundary of two size classes belongs to the lower size class.**

Example 1: A diameter that falls on the class boundary between 10 and 12 centimetres (cm) must be read as 10 centimetres.

If a log has a regular sawn surface, a fair diameter measurement must be taken **without seeking** the largest or smallest diameter (see Figure 1).

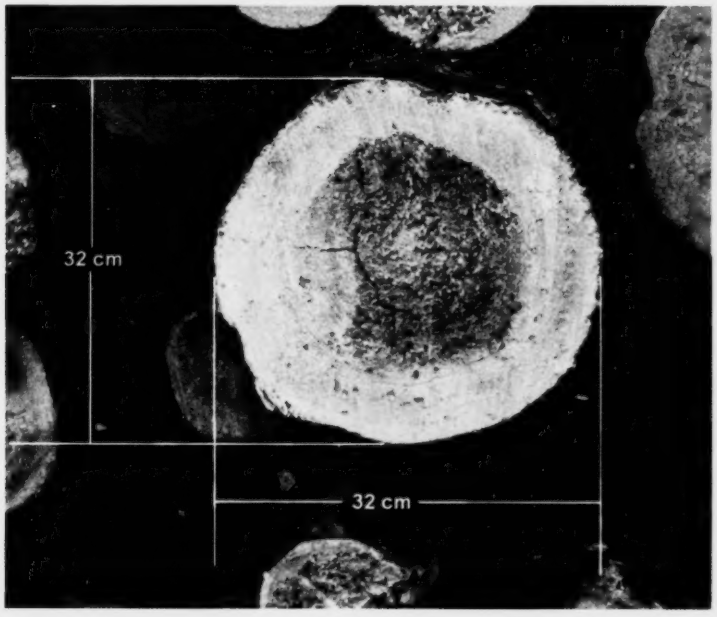


Figure 1 - Measuring diameters: logs with regular sawn surfaces

Logs with irregular sawn surfaces require at least two measurements taken at right angles to each other (through the shortest axis and longest axis of the sawn surface). When the average of two diameter measurements is an odd number, **the diameter recorded is the closest even diameter divisible by 4** (see Figure 2).

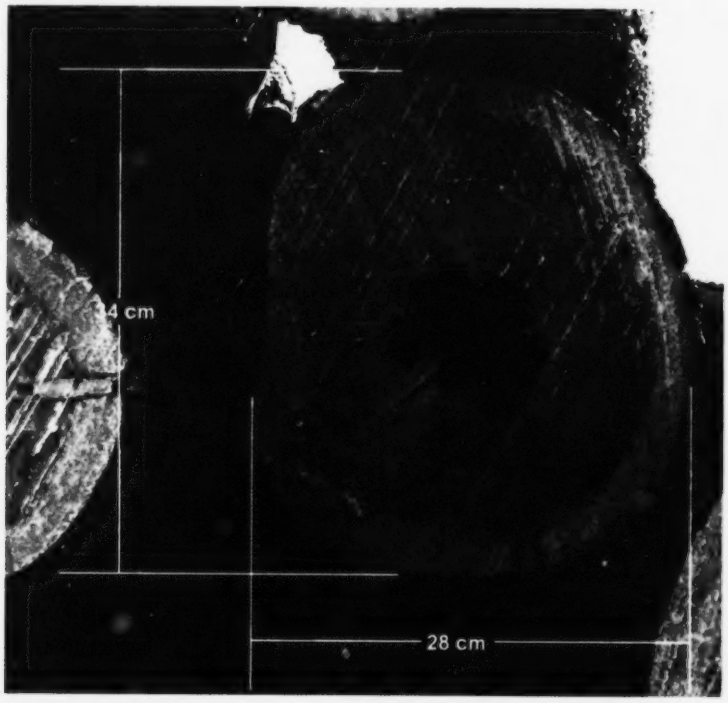


Figure 2 - Measuring diameters: logs with irregular sawn surfaces

Example 2: A diameter measuring 28 by 34 cm is recorded as 32 cm.

$$\frac{(28 + 34)}{2} = \frac{62}{2} = 31 \text{ cm}$$

Since 31 is an odd number, it cannot be recorded. The scaler must record 30 or 32. Since 32 is evenly divisible by 4 and 30 is not, the scaler records **32 cm**.

Example 3: A diameter measuring 10 by 12 cm will be recorded as 12 cm.

$$\frac{(10 + 12)}{2} = \frac{22}{2} = 11 \text{ cm}$$

Since 11 is an odd number, the scaler must record 10 or 12, but only 12 is evenly divisible by 4. Therefore the diameter recorded is **12 cm**.

For timber up to and including 5.7 metres (m) in length piled in skidways, diameters are measured from one side of the skidway, provided that there is an even distribution of butt and top ends on each side. Sides of skidways to be measured will be chosen randomly and marked clearly.

If there is a predominance of tops, butts or defects showing on one side of the skidway, alternate sides may be measured from skidway to skidway to obtain a fair scale. Overall, the scaler must ensure that there are equal numbers of pieces measured from both sides of the skidway.

When **individual** logs are encountered, measure **both ends of the log** to obtain the mean diameter.

(b) Length

Length is **either** measured **or** determined by comparison with an adjacent measured log and recorded in **metres and 20 centimetre classes** with the class boundary occurring on the even centimetre. Lengths are recorded in the **odd centimetre class** (see Figure 3).

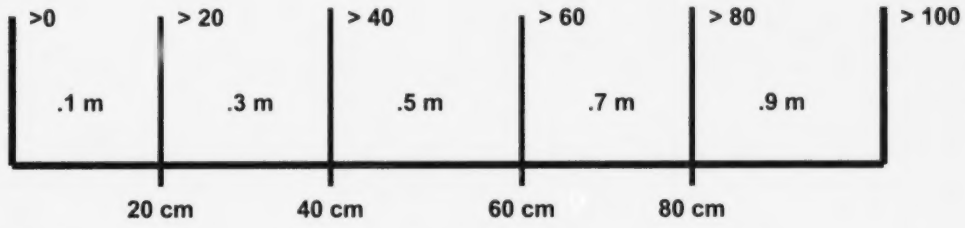


Figure 3 – Diagram showing how length classes are determined

Example 1: Logs greater than 5.0 m in length, **up to and including** 5.2 m in length, are recorded as 5.1 m logs.

3. CALCULATION OF VOLUME

Timber up to and including 5.7 metres in length

Measure and record all logs by species, diameter class and length class.

The procedure for calculating volume is to calculate the area of the sawn surface in square metres at the measured end of the log, then multiply that area by the length of log in metres.

$$\text{Volume} = \frac{D^2 \times 0.7854 \times L}{10{,}000} = \textbf{cubic metres correct to 3 decimal places}$$

Where:

D = diameter of log or defect in 2 centimetre classes
L = length of log or defect in metres and 20 centimetre classes

Appendix C, Table 2, shows the volume in cubic metres for logs of various lengths and diameter classes.

4. DEFECTS

(a) Common Defects

Heart Rot – This is a very common defect. It may occur either as a hole or as rotten wood. It may extend throughout the length of the log and appear on both ends (see Figure 4).

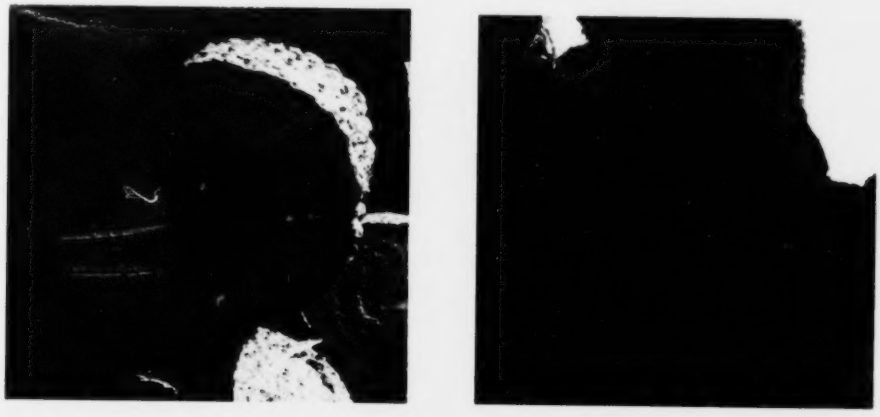


Figure 4 - Examples of heart rot

Stump Rot – This defect, which occurs only in butt logs, seldom extends far into the log. Ordinarily, it reduces in size from the end of the log inward (see Figure 5).

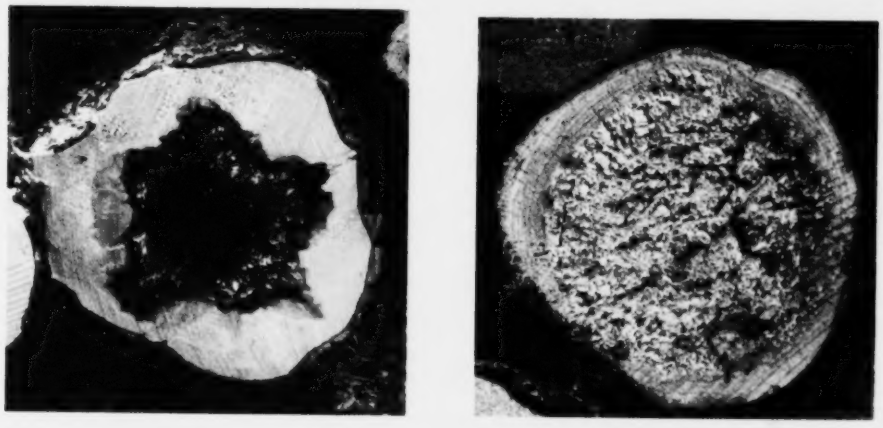


Figure 5 - Examples of stump rot

Heart Check – Overmature timber often shows a heart check, which may extend only part way into the log or may appear on both ends. Heart check must not be confused with sun check or with checks resulting from the normal drying process (see Figure 6).

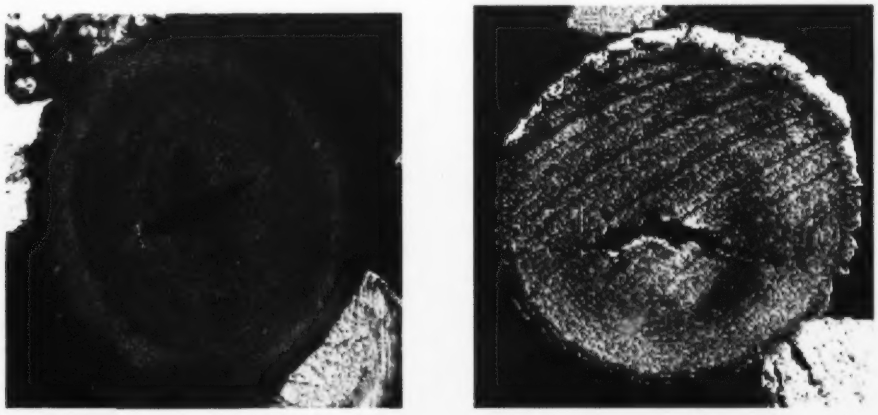


Figure 6 - Examples of heart check on the end surface of a log

Shake – This is the complete separation of one (or more) adjacent annual rings in a log. Shake is believed to be caused before a tree is felled as a result of its swaying back and forth in the wind. If it extends through the entire length of the log, it will appear on both ends. Before shake is considered a defect, it must form at least a half circle within the same ring or closely associated annual rings (see Figure 7).

In the cubic method of measurement, deductions for shake are made in white pine, red pine and hemlock species only.

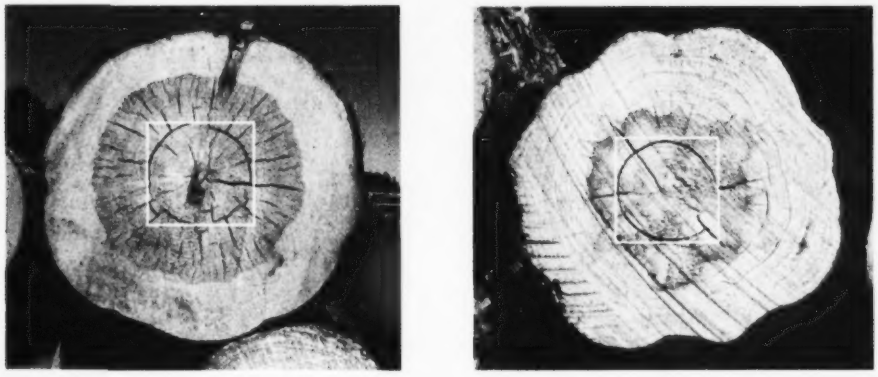


Figure 7 - Examples of shake

Punk Rot – This rot may be fully confined to the heart of the log or it may touch the outer surface (see Figure 8).

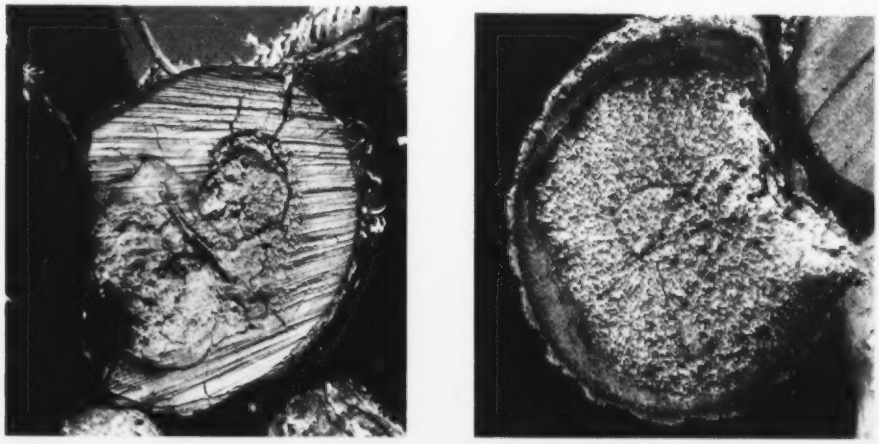


Figure 8 - Examples of punk rot

Note: In the *Cubic Method* of measurement:

- **No deduction is made for crook, sweep or seams.**
- **No deduction is made for stain or mechanical damage.**
- **Sound dry wood is not considered a defect.**
- **Defects appearing at one end of a log up to and including 5.7 metres in length are assumed to extend through the entire length of the log.**

(b) Diameters of Defects

Defects are measured in the same way as gross diameters, **in 2 centimetre size class intervals**, with the class boundary occurring on the odd centimetre. Defects are recorded in even-centimetre classes. **A measured defect that coincides with the boundary of two size classes belongs to the lower size class.**

Example 1: A rot that falls on the class boundary between 8 and 10 cm must be read as an 8 cm defect.

Oblong defects are measured as described in Measuring Procedure on page 5 (irregular sawn surfaces). Enclose the defect in the smallest rectangle possible and obtain the length and width of this rectangle. Add these measurements together and divide by 2 to obtain the mean. **If the mean is an odd number, raise or lower the diameter to the closest even centimetre class that is divisible by 4.**

Example 2: A log contains a defect that measures 10 by 14 cm.

$$\frac{(10 + 14)}{2} = \frac{24}{2} = 12 \text{ cm}$$

The diameter of defect is **12 cm**.

Example 3: A log contains a defect that measures 12 by 18 cm.

$$\frac{(12 + 18)}{2} = \frac{30}{2} = 15 \text{ cm}$$

The diameter of the defect is 15 cm.

Since 15 is an odd number, the scaler must raise this diameter to 16 cm (16 is evenly divisible by 4 while 14 is not). Therefore, the diameter of the defect is **16 cm**.

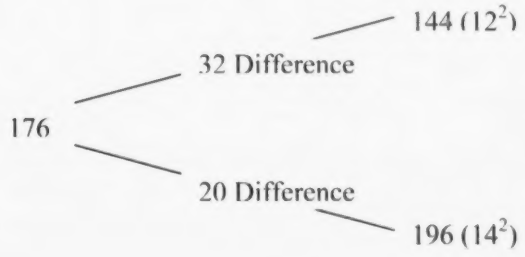
(c) Long Narrow Defects

When the **length of a defect is more than twice its width**, the scaler must first calculate the area of the defect by multiplying the length by the width. The diameter of the defect is then determined by obtaining the square root of this number and raising or lowering it to the closest perfect square root that is an even number. Appendix C, Table 1, shows the squares of all even numbers from 4 to 90.

Example 1: A defect measures 22 by 8 cm. Since the length is more than twice the width, the area of the defect is determined by multiplying 22 x 8 = 176 cm² (see Figure 9).

Since $\sqrt{176} = 13.3$ and 13.3 is an odd number, it must be raised or lowered to the closest perfect square root that is an even number, which is 14. Therefore, the diameter of the defect is recorded as **14 cm**.

Alternatively, referring to Appendix C, Table 1,it will be noted that 176 falls between 144 (12^2) and 196 (14^2). Since 176 is closer to 196, the diameter of the defect is **14 cm**.



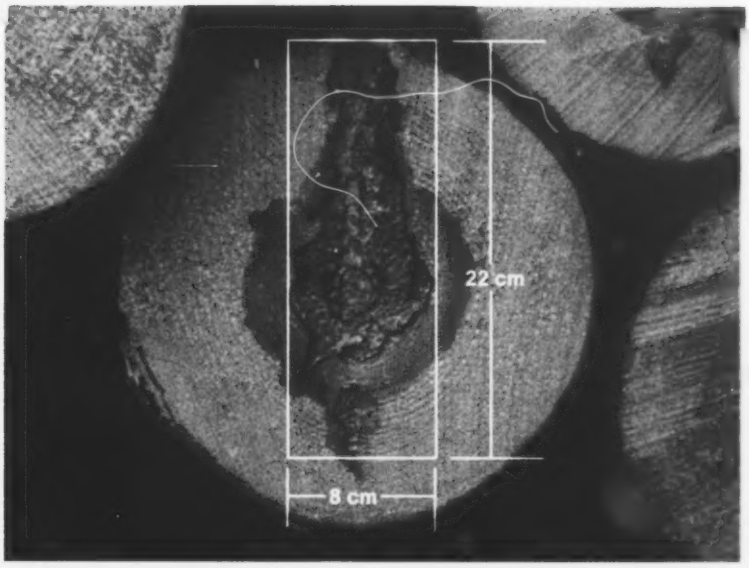


Figure 9 - Example of a long narrow defect that measures 22 cm x 8 cm

(d) Defects separated by 14 centimetres or less

If a log contains two separate defects that are separated by 14 centimetres or less of sound wood, they must be considered as one defect. The scaler must enclose them in a rectangle to obtain the diameter of the defect (see Figure 10).

Figure 10 - Example of two defects separated by 14 cm or less

Example 1: A log contains two defects that are separated by 6 cm of sound wood. The scaler encloses these defects in a rectangle measuring 10 by 18 cm.

$$\frac{(10 + 18)}{2} = \frac{28}{2} = 14 \text{ cm}$$

The diameter of the defect is **14 cm.**

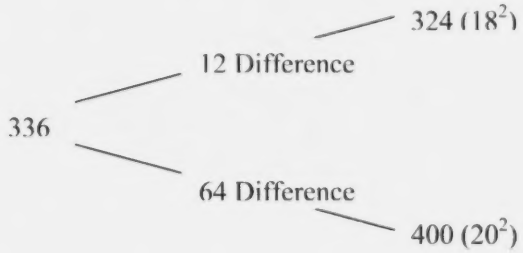
Example 2: A log contains two defects that are separated by 10 cm of sound wood. The rectangle enclosing these defects measures 28 by 12 cm. Since the length is more than twice the width **(long narrow defect)**, the scaler must calculate the area of the defect, obtain the square root and raise or lower this number to the closest perfect square root that is an even number.

Area of defect = 28 x 12 = 336 cm^2

$$= \sqrt{336} = 18.3$$

The diameter of the defect is therefore **18 cm**.

Alternatively, referring to Appendix C, Table 1,it will be noted that 336 falls between 324 (18^2) and 400 (20^2). Since 336 is closer to 324, the diameter of the defect is **18 cm**.



(e) Defects separated by more than 14 centimetres

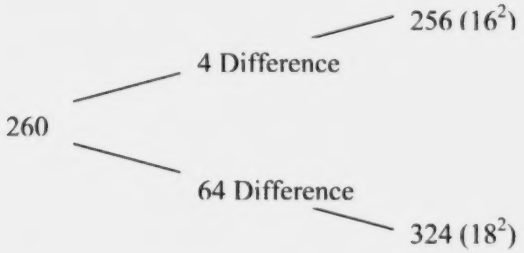
When two defects are separated by **more than** 14 centimetres of sound wood, the scaler must calculate the area of each defect, add them together, and obtain the square root of this total. This result will then be raised or lowered to the closest perfect square root that is an even number to determine the defect diameter.

Example 1: A log contains two defects. One measures 10 by 12 cm and the other measures 10 by 14 cm. They are separated by 16 cm of sound wood.

Area of defects = 10 x 12 = 120 cm^2
= 10 x 14 = 140 cm^2
260 cm^2

$$= \sqrt{260} = 16.12$$

Therefore, the diameter of the defect is **16 cm**. This can also be determined by referencing Appendix C, Table 1.



(f) Sap Rot Defect

Sap rot is a defect confined to the outer circumference of the log where the heartwood may be unaffected and sound. Diameters must be determined for both the gross and the sound portions of the log. The square of the sound diameter, subtracted from the square of the gross diameter, represents the square of the defect. **If the square of the defect is less than the square of the sound diameter, the log is not a cull and the diameter of the sound portion is recorded.**

Example 1: A log in a skidway has a diameter of 40 cm and a sap rot on the circumference; leaving 32 cm of sound wood (see Figure 11).

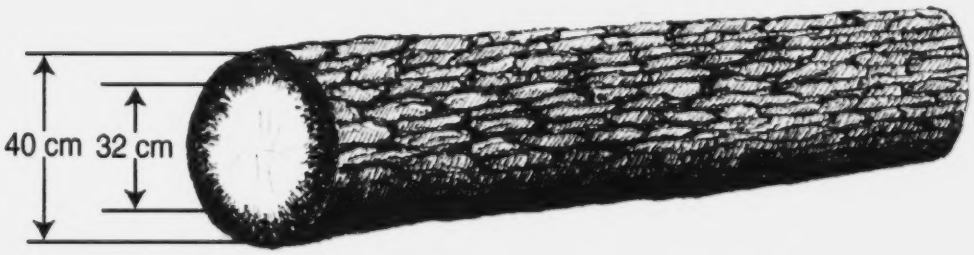


Figure 11 - Example of sap rot

Gross diameter² (40 x 40)	=	1600 cm²
Minus diameter² of sound wood (32 x 32)	=	- 1024 cm²
Defect	=	576 cm²

Since the squared diameter of the defect portion is less than the squared diameter of the sound portion, the log is not a cull. The diameter of the sound portion of the log is recorded as **32 cm**.

(g) Cull

Any log having **more than one-half of its volume defective** is considered to be a cull. Culls can easily be determined by comparing the square of the defect diameter with the square of the sawn surface diameter. If the square of the defect diameter **is greater than one-half** of the square of the sawn surface diameter, the log is a **cull**. Culls are indicated by a distinct mark (e.g. "X", the word "Cull", etc.) on the sawn surface and are tallied by species and piece (see Figure 12).

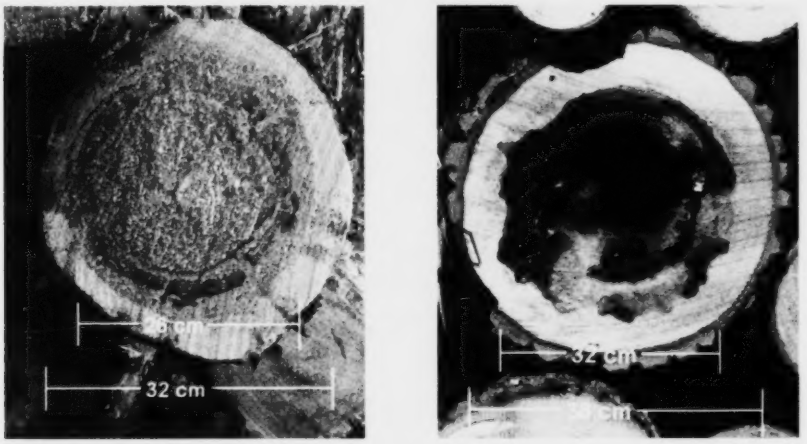


Figure 12 - Examples of cull logs

Example 1: A log with a gross diameter of 32 cm has a 26 cm defect on the measured end. The square of the log diameter is 32 x 32 = 1024 cm². The square of the defect diameter is 26 x 26 = 676 cm².

Gross diameter	= 32 x 32 = 1024
Defect diameter	= 26 x 26 = - 676
Sound portion	= 348

Since 676 is more than half of 1024, the log is a **cull**.

(h) Applying Defect Deductions

All **sound or merchantable pieces**, regardless of their diameter, length and species, must be scaled and returned to the Ministry; they cannot be considered rejects or culls.

When measuring logs piled in **skidways**, deductions for defects are calculated by measuring the diameter of defects visible on the sawn surface on the **measured side** of the skidway. It is assumed that any such defect extends through the **full length of the log** and that there is an even distribution of defects on both sides of the skidway.

When **individual** logs are encountered, measure the defect on **both ends of the log** to obtain the mean defect diameter.

Deductions are made by reducing the diameter of the log either by referring to Appendix C, Table 3, by reading directly from the scaling sticks (MC-1 or MC-2), or through manual calculations.

Example 1: A log in a skidway has a gross diameter of 36 cm and a rot of 12 cm. Using Appendix C, Table 3, a 12 cm rot requires a 2 cm reduction off the gross diameter. Therefore, the net diameter of this log will be **34 cm**.

OR

Reading from the MC-1 cube rule, a 36 cm log with a 12 cm defect reduces the gross diameter by 2 cm for a net diameter of **34 cm**.

OR

Manual calculation:

Gross diameter squared	$= 36 \times 36 = 1296\ cm^2$
Defect diameter squared	$= 12 \times 12 = -\ 144\ cm^2$
Difference	$= 1152\ cm^2$

The closest even square to 1152 is 1156. The square root of 1156 is 34; therefore, the scaler would record a net diameter of **34 cm**.

5. UNDERSIZE

In the cubic method, undersize is defined as:

- conifers other than white pine, red pine or hemlock that have a gross diameter less than 10 centimetres (diameter class).

- white pine, red pine, hemlock, poplar or white birch that have a gross diameter less than 16 centimetres (diameter class).

When measuring undersize material, the scaler will record the gross diameter of the undersize pieces by species and length.

The scaler will not reduce the gross diameter of the undersize piece if defect is encountered.

6. LONG TIMBER, 5.9 METRES AND LONGER

Long timber is defined as any log, 5.9 metres or longer in length, which has been cut to a defined product length (e.g. utility poles, logs for buildings).

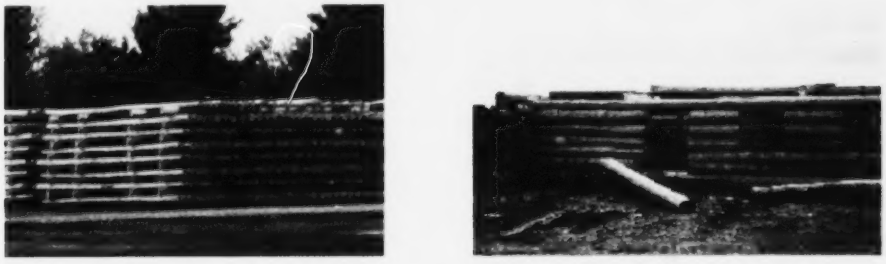


Figure 13 - Examples of poles and building logs

a) Diameters

Diameters are measured on both ends of each log and averaged to obtain the mean diameter. This mean diameter is raised or lowered to the nearest even diameter class divisible by 4.

Example 1: (see Figure 14): Butt diameter = 44 cm

Top diameter = 14 cm

Mean diameter = $\frac{58}{2}$ = 29 cm

Since 29 is an odd number, it cannot be recorded. The scaler must record either 28 or 30. Since 28 is evenly divisible by 4, record **28 cm**.

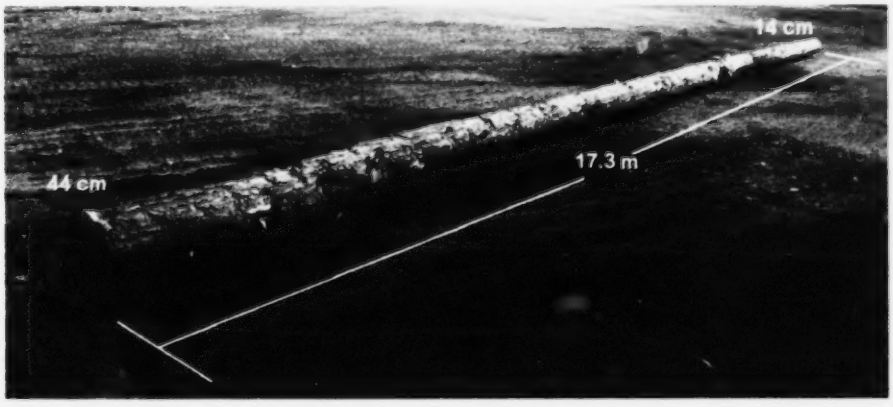


Figure 14 - Example of long timber

b) Defects

If a defect appears on one end only, in a piece of long timber, it is assumed to extend 2.5 m into the piece (see Figure 15).

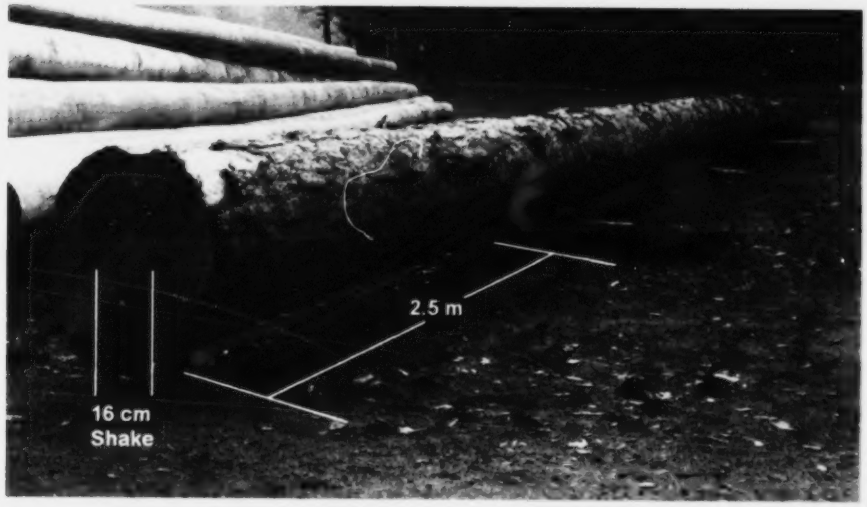


Figure 15 - Example of long timber with defect affecting one end only

If a defect appears at both ends, calculate the mean diameter of the defect and reduce the gross mean diameter of the log according to the volume of the defect.

c) Calculation of Volume

Measure and record all logs by species, diameter class and length class.

$$\text{Volume} = \frac{MD^2 \times 0.7854 \times L}{10{,}000} = \textbf{cubic metres correct to 3 decimal places}$$

Where:

MD = mean diameter in 2 centimetre classes
L = length in metres and 20 centimetre classes

Example 1: A piece of long timber measuring 8.9 m in length, has a diameter of 42 cm on the butt end and 14 cm on the top end of the log. There is a defect showing on the butt that measures 16 cm in diameter. To determine the net diameter to tally, the following steps must be taken.

Step # 1

Calculate the mean diameter of the log:

Butt diameter = 42 cm
Top diameter = 14 cm

$$\frac{(42 + 14)}{2} = \frac{56}{2} = 28 \text{ cm}$$

Mean diameter of the log is **28 cm**.

Step # 2

Calculate the gross volume of the log:

$$\frac{MD^2 \times 0.7854 \times L}{10{,}000} = \textbf{cubic metres correct to 3 decimal places}$$

$$\frac{28 \times 28 \times 0.7854 \times 8.9}{10{,}000} = 0.54802$$

$= 0.548 \text{ m}^3$

Gross volume of log is **0.548 m^3**.

Step # 3

Calculate the defect volume of the log:

$$\frac{\text{Defect } D^2 \times 0.7854 \times L}{10{,}000} = \textbf{cubic metres correct to 3 decimal places}$$

$$\frac{16 \times 16 \times 0.7854 \times 2.5}{10{,}000} = 0.05026$$

$= 0.050 \text{ m}^3$

Defect volume of log is **0.050 m^3**.

Step # 4

Calculate the sound volume of log by subtracting the defect volume from the gross volume:

Gross volume	=	0.548
Defect volume	=	- 0.050
Sound volume of log	=	**0.498 m^3**

Step # 5

After the sound volume is calculated, go to Appendix C, Table 2, look up the volume closest to 0.498 m^3 in the 8.9 m length class to get a diameter to record.

26 cm diameter log with a length of 8.9 m = 0.473 m^3
28 cm diameter log with a length of 8.9 m = 0.548 m^3

Since the sound volume of 0.498 m^3 is closer to 0.473 m^3, the scaler would record a net diameter of **26 cm** in the 8.9 m length class.

7. IDENTIFICATION OF SKIDWAYS

When a skidway or group of skidways is measured, the scaler must place the following information on the end of one or more conspicuous logs in each skidway (see Figure 16):

- skidway number
- date
- scaler's initials
- any other information requested by the **Ministry's Regional Measurement Coordinator**

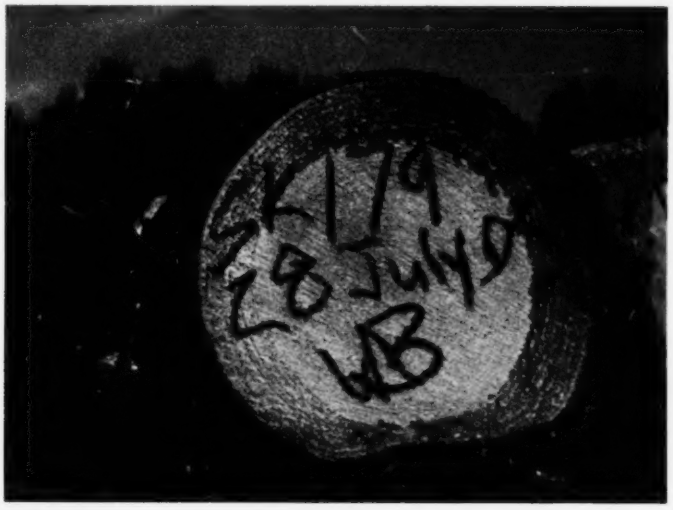


Figure 16 - Example of skidway identification

Skidways are numbered consecutively for each Approval to Commence Harvesting Operations (harvest approval). Closely situated skidways may be tallied together, provided the total number of **measured logs does not exceed 1,000**. These are known as groups of skidways, and they must be properly identified. **This grouping must not occur without prior approval from the Ministry's Regional Measurement Coordinator.**

All pieces of timber, when scaled, must be properly marked.

Note: If sample scaling in the cubic method, see Section III, H for detailed measuring procedures.

B. TREE LENGTH METHOD

All conifer, poplar and white birch may be measured by the tree length method. This method of scaling is used for harvesting operations where trees are felled, skidded and piled before further processing is done (e.g. slashing or chipping).

1. UNIT OF MEASUREMENT

Cubic metre

2. MEASURING PROCEDURE

Butt diameters are measured **inside the bark**, in **2 centimetre classes**, the **narrow way through the geometric centre of the butt surface**, following the **natural taper** of the stem, **disregarding abnormal depressions and flares** (see Figure 17).

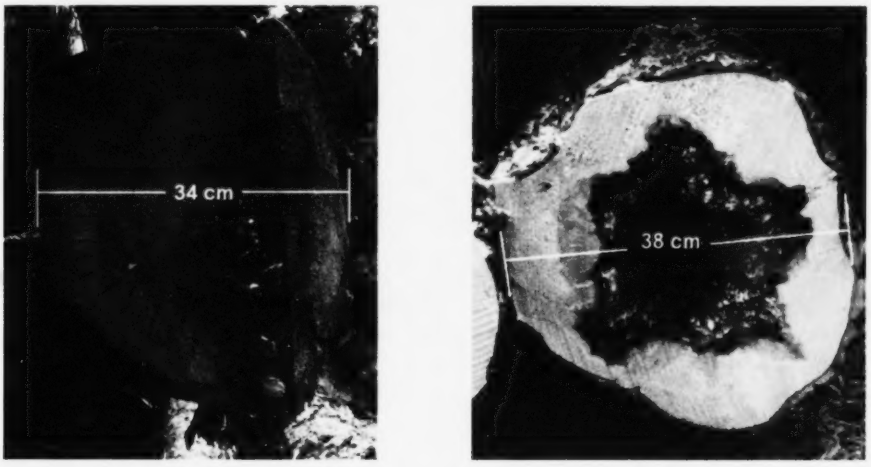


Figure 17 - Measuring tree length butt diameters

All tree length pieces, regardless of size, must be measured and recorded.

No deductions are made by the scaler for undersize, cull or defect. These deductions are determined using the Ministry's volume and value calculation computer software.

3. CALCULATION OF VOLUME

Measure and record the tree length stems by species and butt diameter class.

Gross volume is calculated by the Ministry's volume and value calculation computer software using data obtained from an appropriate tree length volume table.

Net volume is calculated by applying Ministry scaling factors for undersize and defect (including cull) to the gross volume.

These tables and factors are derived from the Ministry's Provincial sampling program.

4. IDENTIFICATION OF SKIDWAYS

When a skidway has been measured, the scaler must mark the following information on one or more conspicuous butt surfaces:

- skidway number
- date
- scaler's initials
- any other information requested by the **Ministry's Regional Measurement Coordinator**

Skidways are to be numbered consecutively for each Approval to Commence Harvesting Operations (harvest approval). Closely situated skidways may be tallied together, provided the total number of **measured tree length stems does not exceed 1,000. This grouping must not occur without prior approval from the Ministry's Regional Measurement Coordinator.**

Large skidways may be broken into smaller sections. Each section should have a separate skidway number and be recorded on a separate tally sheet.

Note: If sample scaling in the tree length method, see Section III, H for detailed measuring procedures.

C. STACKED WOOD METHOD

All conifer, poplar, white birch and grade 2 hardwoods up to and including 2.80 metres in length may be measured by this method.

1. UNIT OF MEASUREMENT

Stacked cubic metre

A stacked cubic metre is one cubic metre of stacked wood (whole or split, with or without bark) containing wood and airspace with all bolts of similar length piled with their longitudinal axes parallel.

2. MEASURING PROCEDURE

Heights and lengths are measured on one side of the stack only, by means of a scaling stick (MS-1 or MS-2), graduated in 2 centimetre classes. The scaler must determine if there is an even distribution of tops, butts and defects on both sides of the stack. If there is a predominance of tops, butts or defects showing on one side of the stack, alternate sides must be measured from stack to stack to obtain a fair scale.

(a) Length

Length of the stack is measured in metres and 2 centimetre size classes with the break occurring on the odd centimetre. Lengths are recorded in the **even centimetre class**.

When a stack drops off in height at one or both ends, measure the length to a point on the slope of the stack where the area of the stack that is now cut off will fill the space required to square the stack (see Figure 18).

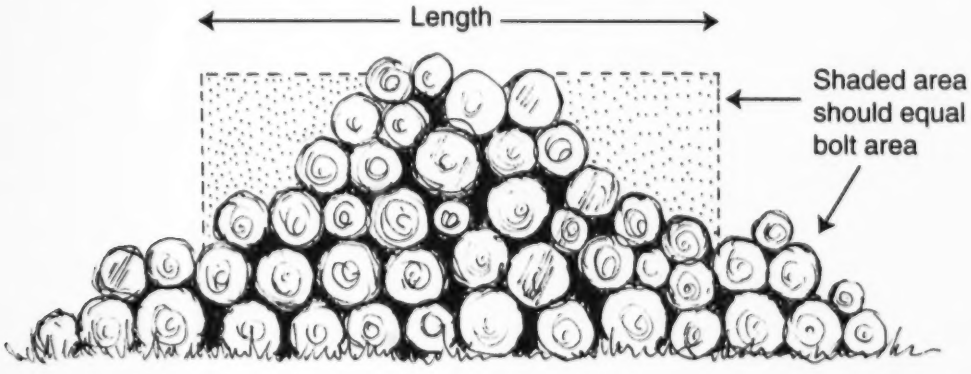


Figure 18 - Measuring length of stack when stack drops off at both ends

On hillsides, measure the length of the stack parallel with the bottom of the stack (see Figure 19).

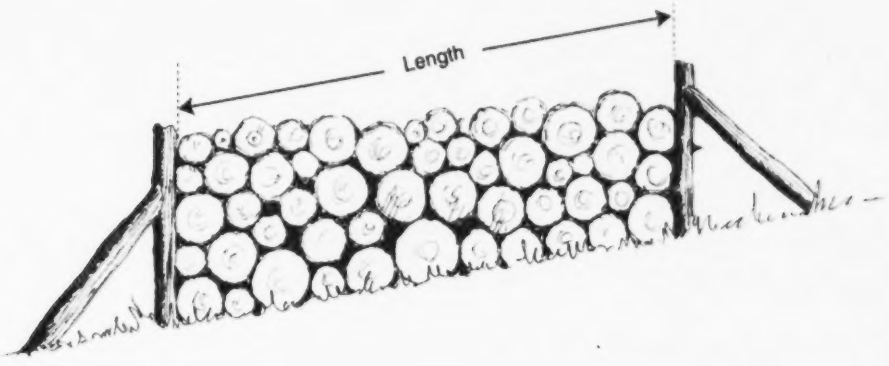


Figure 19 - Measuring length of stack on a slope

The maximum recordable length of a stack is 50.00 metres. Where exceedingly long stacks are encountered, separate them into sections no longer than 50.00 metres. Measure and record each section as a separate stack and mark each section of the stack clearly with a line.

(b) Height

Height is measured in metres and 2 centimetre size classes with the break occurring on the odd centimetre and recorded in even centimetre classes. Heights are measured at **equal intervals** along the length of a stack, and averaged to two decimal places to obtain the average height of a stack (see Figure 20).

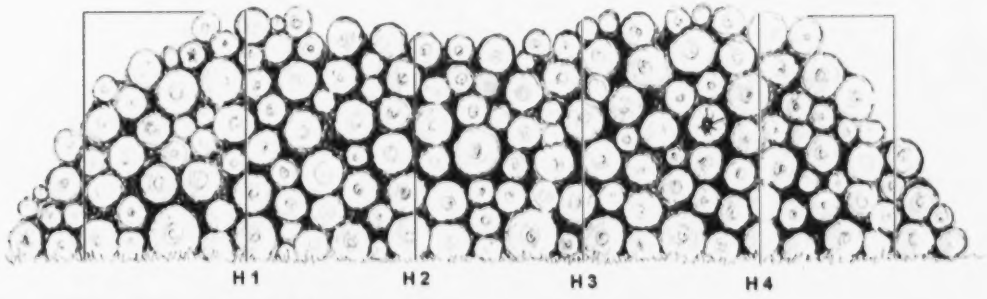


Figure 20 - Measuring height of stack

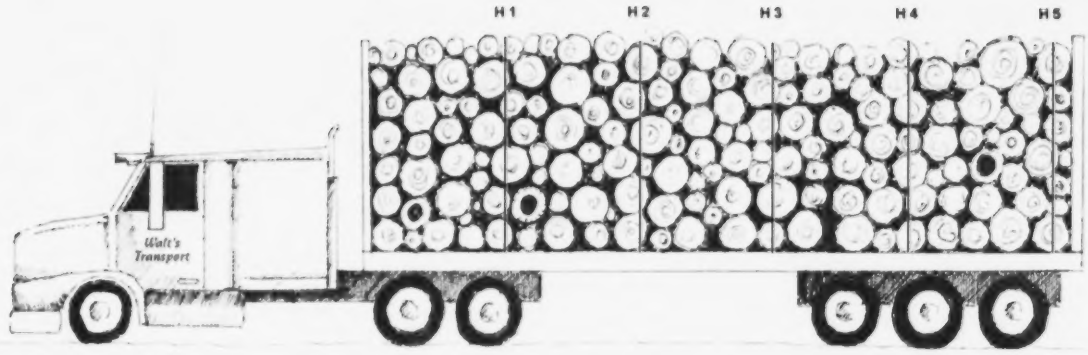


Figure 21 - Height measurements taken on a loaded truck

The maximum allowable height of a stack is 5.00 metres.

Example 1: Determining stack height from measurements taken at equal intervals along the length of a stack:

1.78 m, 1.84 m, 1.84 m

Average height of stack is $\frac{(1.78 + 1.84 + 1.84)}{3} = \frac{5.46}{3} = 1.82$ m

Record the height as **1.82 m**.

When a number of height measurements are averaged to two decimal places, odd numbers may be recorded for the height measurement. **Rounding of numbers does not apply to averaged stack heights. The third and subsequent decimal places are disregarded.**

Example 2: Height measurements, taken at equal intervals along the length of a stack resulting in an odd number:

1.52 m, 1.58 m, 1.58 m, 1.54 m.

Average height of stack is $\frac{(1.52 + 1.58 + 1.58 + 1.54)}{4} = \frac{6.22}{4} = 1.555$ m

Record the height as **1.55 m (the third decimal place is disregarded).**

More height measurements are required on stacks with irregular heights.

Where wood is stacked on a slope, the height measurements are taken at right angles to the slope (see Figure 22).

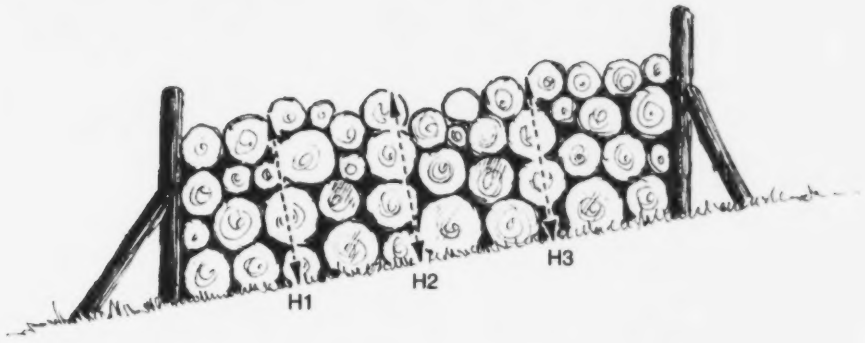


Figure 22 - Measuring height of stack piled on a slope

(c) Width

The width of a stack is the length of the bolts in metres and 2 centimetre classes with the break occurring on the odd centimetre and recorded on the even centimetre class. All the wood in one stack must be the same length. **Wood more than 2.80 metres in length can not be stack scaled.**

3. CALCULATION OF VOLUME

To calculate the number of stacked cubic metres in a stack, multiply the height of the stack by the length of the stack by the width of the stack (see Figure 23).

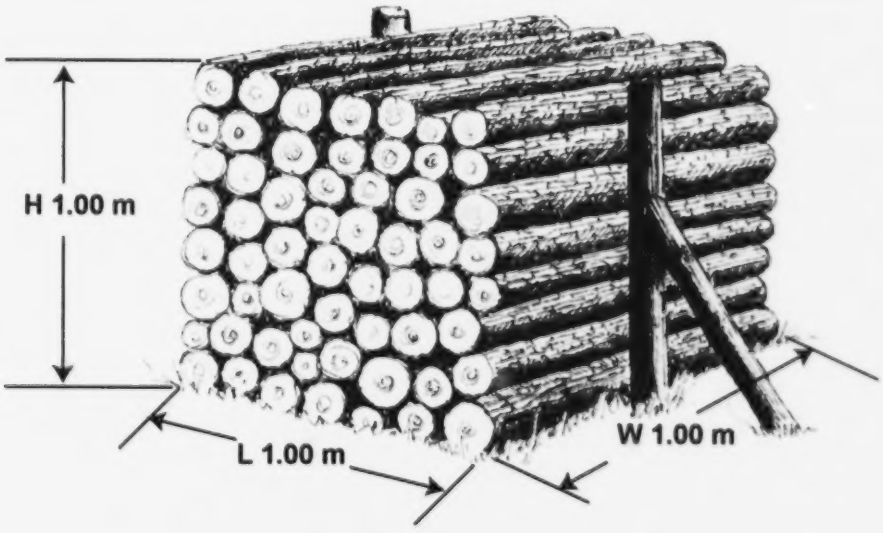


Figure 23 - Example of 1 stacked cubic metre

Volume = H x L x W = **stacked cubic metres correct to 2 decimal places**

Where:

H = height of stack in metres and 2 centimetre classes
L = length of stack in metres and 2 centimetre classes
W = width of stack (length of bolt) in metres and 2 centimetre classes

Example 1: A stack of wood measuring 2.50 m in height, 4.00 m in length and 2.60 m in width has a volume of 2.50 x 4.00 x 2.60 = **26.00 m³ (st)** (see Figure 24).

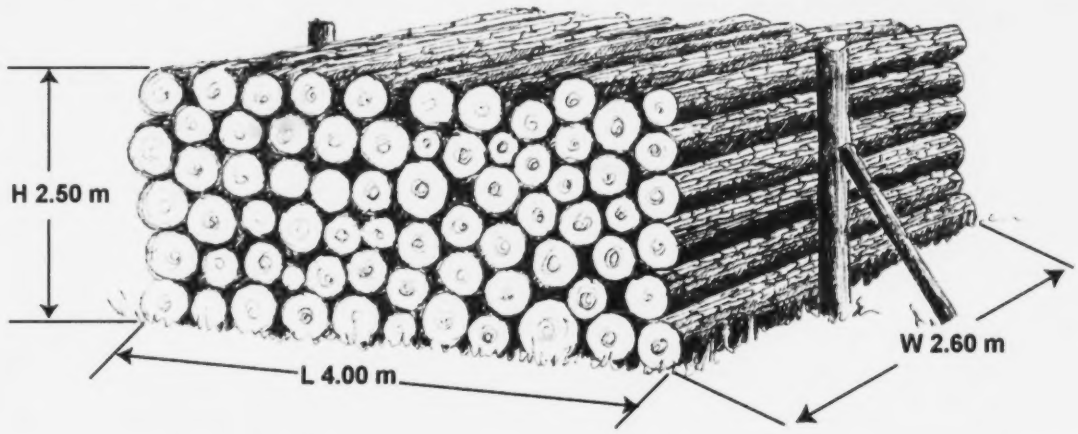


Figure 24 - Example of stacked wood

Appendix C, Table 6, gives the volume in stacked cubic metres of 1.26 m and 2.54 m wood in stacks of various lengths and heights.

4. DEFECTS

Deductions for defects are calculated from diameter measurements of defects visible **on the sawn surfaces of the wood on the side of the stack being measured**. It is assumed that any visible defect **extends through the full length of the bolt** and that there is an **even distribution** of defects on both sides of the stack.

(a) Culls and Deductions in Conifer, Poplar and White Birch

Any bolt having **more than one-half of its volume defective** is considered to be a cull. A bolt is a cull if the square of the defect diameter is greater than one-half of the square of the sawn surface diameter. Culls are indicated by a distinct mark (e.g. "X", the word "Cull", etc.) on the sawn surface.

There is no deduction for defect on undersize bolts.

Procedure for determining defect volume when stack scaling conifer, poplar and white birch:

- Measure gross diameter and defect diameter of the major species using the cube scaling stick (MC-1) (see Section IV(g)).

- Using the cubic method, determine whether the defective bolt is a cull. If it is a cull, use the gross diameter of the bolt to calculate the volume of the defect.

- If the bolt is not a cull, use the defect diameter to calculate the volume of the defect. This can be derived in two ways: it can be read directly from the cube scaling stick (for 2.54 m length bolts) marked in hundredths of a stacked cubic metre or it can be taken from Appendix C, Table 5, which gives volumes in stacked cubic metres, by diameter class, for wood 1.26 m or 2.54 m in length.

- Reduce the gross volume of a stack by the volume of defect to obtain the net volume of a stack by species.

Example 1: A 2.54 m rough balsam fir bolt with a diameter of 38 cm has a 16 cm rot on the measured end that is not large enough to cull the bolt. Referring to Appendix C, Table 5, it will be noted that a 16 cm defect has a volume of 0.08 m^3 (st). Therefore the gross volume of the stack would be reduced by 0.08 m^3 (st).

Example 2: A stack of 2.54 m rough spruce contains one bolt 26 cm in diameter with a 20 cm defect. Since this defect is large enough to cull the bolt, the volume of the deduction will be based on the 26 cm gross diameter. Appendix C, Table 5, shows a volume of 0.20 m^3 (st) for a 26 cm bolt, 2.54 m long. Therefore, the gross volume of the stack would be reduced by 0.20 m^3 (st).

(b) Culls and Defects for Grade 2 Hardwoods

There are no deductions for defect or cull logs when stack scaling grade 2 hardwoods.

5. VOIDS

A void is an **unnecessary air space**, large enough to accommodate an average size bolt in the stack.

For a large void with an average diameter equal to or greater than twice the diameter of the average size bolt in the stack, the number of average size bolts required to fill the void will be estimated and deductions made on the basis of their volume.

The volume of a void, in stacked cubic metres, can be read directly from the cube scaling stick (MC-1), for 2.54 m length bolts, marked in hundredths of a stacked cubic metre or it can be taken from Appendix C, Table 5.

Deductions for voids are made in the same manner as for culls and recorded in hundredths of stacked cubic metres.

6. UNDERSIZE BOLTS

In the stacked method, undersize is defined as:

- conifers other than white pine, red pine or hemlock that have a gross diameter less than 10 centimetres (diameter class).
- white pine, red pine, hemlock, poplar or white birch that have a gross diameter less than 16 centimetres (diameter class).
- grade 2 hardwoods that have a gross diameter less than 20 centimetres (diameter class).

All undersize bolts in the stack will be scaled **on the side of the stack being measured** and their gross volume recorded in stacked cubic metres. Deductions are made in the same manner as for culls.

The diameter of an undersize bolt is measured with the cube scaling stick (MC-1). Its volume, in stacked cubic metres, can be read directly from the cube scaling stick for 2.54 m length bolts or it can be taken from Appendix C, Table 5.

7. MINOR SPECIES

All minor species in the stack will be measured **on the side of the stack being scaled** and their **net volumes** recorded in stacked cubic metres.

The diameters of minor species bolts are measured with the cube scaling stick (MC-1). The net volume, in stacked cubic metres, can be read directly from the cube scaling stick for 2.54 m length bolts or it can be taken from Appendix C, Table 5.

Note: The volumes by diameter class for defect, void, undersize and/or minor species shown on the MC-1 stick are for wood 2.54 m in length. If the length of wood being measured is different than 2.54 m, and volumes of defect, void, undersize and/or minor species are being <u>calculated manually</u>, the volumes shown on the MC-1 stick or shown in Appendix C, Table 5, will have to be adjusted. To make this adjustment, multiply the volumes shown by the length of the wood being measured and divide by 2.54.

Example 3: A stack of 2.80 m rough spruce contains one bolt 26 cm in diameter with a 20 cm defect. Since this defect is large enough to cull the bolt, the volume of the deduction will be based on the 26 cm gross diameter.

Appendix C, Table 5, shows a volume of 0.20 m^3 (st) for a 26 cm bolt, 2.54 m long. To determine the volume for a 2.80 m bolt, multiply the volume of 0.20 m^3 (st) by 2.80 and divide the result by 2.54.

Volume of the 2.80 m bolt = $\frac{0.20 \times 2.80}{2.54}$ = 0.22 m^3 (st).

The gross volume of the stack would be reduced by **0.22 m^3 (st)**.

8. PROCEDURE FOR DETERMINING NET VOLUME OF A STACK

When calculating the net volume of the major species, determine the sound portion of the stack by subtracting the volume representing all deductions from the gross volume of the stack. Subtracting the net volume of each minor species from the sound portion of the stack will result in the determination of the net volume of the major species.

When recording stacked wood, all volumes are recorded in stacked cubic metres by species. Culls, defects, undersize and voids are recorded in stacked cubic metres only. When determining the volume of any minor species, make sure that **only the net volume** of the bolts of that particular species is included.

Example 1: A stack of 2.54 m rough wood is 7.32 m long and 1.28 m high. In addition to sound spruce, it contains the following minor species, defects and undersize bolts (see Figure 25):

- two 8 cm undersize jack pine bolts
- one 30 cm spruce bolt with a 24 cm defect
- one 26 cm balsam fir bolt with a 16 cm defect
- four 16 cm sound balsam fir bolts

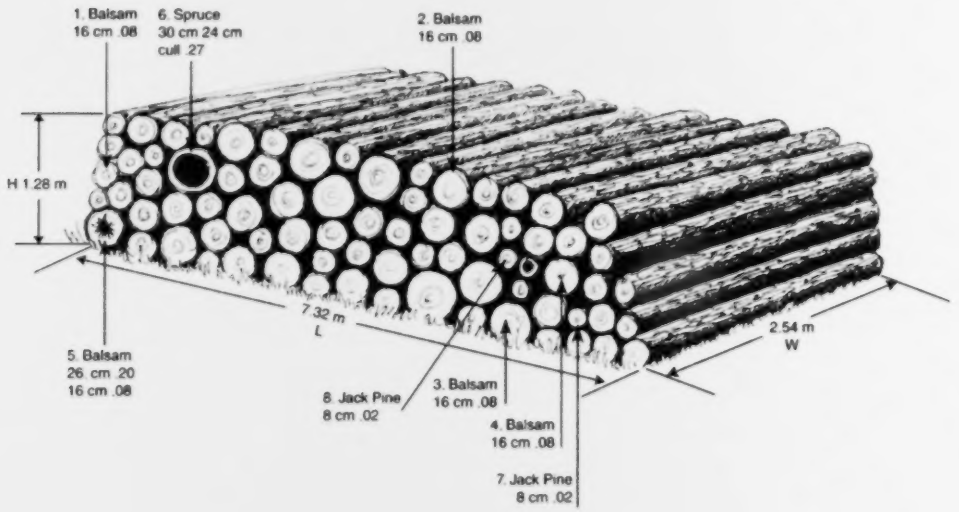


Figure 25 - Representation of the stack described in Example 1

To determine the net volume of spruce in this stack:

Step # 1

Gross Volume of stack is:

H x L x W = stacked cubic metres correct to 2 decimal places
1.28 x 7.32 x 2.54 = 23.79898
= 23.80 m^3 (st)
Gross volume of the stack is **23.80 m^3 (st)**.

Step # 2

Calculate the volume of undersize, defect, and minor species in the stack:

i) **Undersize Deduction**

Jack pine (2) - Bolt numbers 7 and 8, 8 cm in diameter
8 cm diameter = 0.02 m^3 (st) as read from MC-1 stick

Undersize volume = 0.02 x 2 = 0.04 m^3 (st)

Undersize volume of the stack is **0.04 m^3 (st)**.

ii) **Defect Deduction**

Spruce (1) – Bolt number 6, 30 cm in diameter is a cull
30 cm diameter = 0.27 m^3 (st) as read from MC-1 stick

Defect volume of this bolt is **0.27 m^3 (st)**.

Balsam fir (1) – Bolt number 5, 26 cm in diameter with a **16 cm defect. This is not a cull.**

16 cm diameter = 0.08 m^3 (st) as read from MC-1 stick

Defect volume of this bolt is **0.08 m^3 (st)**.

Total defect volume of the stack is 0.27 + 0.08 = **0.35 m^3 (st)**.

iii) **Minor Species Deduction**

Balsam fir (4) – Bolt numbers 1 to 4, 16 cm in diameter
16 cm diameter = 0.08 m^3 (st) as read from MC-1 stick

Volume of the bolts = 0.08 x 4 = 0.32 m^3 (st)

Balsam fir (1) – Bolt number 5, sound portion of bolt that measures 26 cm in diameter with a 16cm defect

26 cm diameter = 0.20 m^3 (st) as read from MC-1 stick
16 cm diameter = 0.08 m^3 (st) as read from MC-1 stick

Gross volume	= 0.20 m^3 (st)
Defect volume	= - 0.08 m^3 (st)
Net volume	= 0.12 m^3 (st)
The net volume of the bolt	= **0.12 m^3 (st)**

Minor species (balsam fir) volume of stack is 0.32 + 0.12 = **0.44 m^3 (st)**.

Step # 3

Calculate the net volume of spruce in the stack:

Gross volume of stack	= 23.80
Less undersize volume	= - 0.04
Less defect volume	= - 0.35
Net volume of stack	= **23.41 m^3 (st)**
Less minor species	= - 0.44
Net volume of spruce	= **22.97 m^3 (st)**

9. IDENTIFICATION OF STACKS

When a stack has been measured, the scaler must mark the following information on one or more conspicuous bolts (see Figure 26):

- stack number over sheet number
- date
- scaler's initials
- any other information requested by the **Ministry's Regional Measurement Coordinator**

Figure 26 - Example of stack identification

Each stack must be marked randomly along its length, from top to bottom, with the letter "S".

Stacks are numbered consecutively for each Approval to Commence Harvesting Operations or as approved by the **Ministry's Regional Measurement Coordinator**.

10. CONVERSION FACTORS FOR ROUGH AND PEELED BOLTS

Tests have determined that, on average, a stacked cubic metre of wood is made up of the following:

66.667%	wood
11.458%	bark
21.875%	air
100.000%	

(a) Rough Wood Factor

In order to calculate the volume of **stacked cubic metres of rough wood** represented by **a single** bolt, undersize, defect, cull or void, the **solid cubic metre** volume must be multiplied by the **rough wood factor 1.50.**

The factor is derived as follows:

$$66.667\%\ \text{wood} \qquad \frac{100\%}{66.667\%} = 1.50$$

Example 1: A single bolt has a volume of 0.063 m^3. To determine the volume of the single bolt in stacked cubic metres:

0.063 m^3 x 1.50 = **0.09 m^3 (st) correct to 2 decimal places**.

(b) Peeled Wood Factor

In order to calculate the volume of **stacked cubic metres** of peeled wood represented by **a single** bolt, undersize, defect, cull or void, the **solid cubic metre** volume must be multiplied by the **peeled wood factor 1.28.**

This factor is derived as follows:

66.667%	wood		
11.458%	bark	100%	= 1.28
78.125%		78.125%	

Example 2: A single peeled bolt has a volume of 0.063 m^3. To determine the volume of the single bolt in stacked cubic metres peeled:

0.063 m^3 x 1.28 = **0.08 m^3 (st) correct to 2 decimal places**.

11. CONVERSION FACTORS FOR STACKS

a) To convert **stacked cubic metres to solid cubic metres**, **multiply** the volume in stacked cubic metres (correct to 2 decimal places) by:

0.67 for rough wood
0.78 for peeled wood

Round all volumes in solid cubic metres **correct to 3 decimal places**.

Example 1: A stack of rough wood has a volume of 36.05 m^3 (st). To determine the volume in solid m^3:

36.05 x 0.67 = **24.154 m^3**.

b) To convert **solid cubic metres to stacked cubic metres**, **divide** the volume in solid cubic metres (correct to 3 decimal places) by:

0.67 for rough wood
0.78 for peeled wood

Round all volumes in stacked cubic metres **correct to 2 decimal places**.

Example 2: A skidway of rough wood has a volume of 358.909 m^3. To determine the volume in stack m^3:

358.909 ÷ 0.67 = **535.69 m^3 (st)**.

D. CUBE GRADE METHOD

All hardwood timber, **except poplar and white birch**, up to and including 5.7 metres in length, may be measured by this method.

1. UNIT OF MEASUREMENT

Cubic metre

2. MEASURING PROCEDURE

(a) Diameter

Diameters are measured inside the bark, in the same manner as described under "Diameters" in Section III (A), "Cubic Method". Logs with irregular sawn surfaces require at least two measurements taken at right angles to each other (through the shortest axis and longest axis of the sawn surface). When the average of two diameter measurements is an odd number, the diameter recorded is the closest even diameter divisible by 4.

(b) Length

Length is **either measured or determined by comparison** with an adjacent measured log, and recorded in **metres and 20 centimetre classes**, with the class boundary occurring on the even centimetre. Lengths are recorded in the **odd centimetre class.**

3. CALCULATION OF VOLUME

$$\text{Volume} = \frac{D^2 \times 0.7854 \times L}{10{,}000} = \textbf{cubic metres correct to 3 decimal places}$$

Where: D = diameter of the log in 2 centimetre classes
L = length of the log in metres and 20 centimetre classes

Appendix C, Table 2, shows volumes in cubic metres for logs of various lengths and diameter classes.

4. GRADING PRINCIPLES

Log grades represent the quality of timber harvested. Three factors must be known by the scaler to determine the grade:

- the position of the log in the tree (butt or upper)
- the minimum small end diameter
- the total allowable percentage of deduction

Gross diameters are recorded by species, length class and grade. **There is no diameter or volume reduction for defect when applying the cube grade method.**

5. SPECIFICATIONS FOR HARDWOOD LOG GRADING

Log Grade	1		2	
1. Position of log in tree	Butt	Upper	Butt	Upper
2. Minimum small end diameter	24 cm and greater	30 cm and greater		
3. Total allowable percentage of deduction	Not more than 25%		Not more than 66⅔%	

Note: for grading purposes only:

- all diameters are measured inside the bark at the small end of the log
- all deductions are expressed in percentages
- assess the entire log, including both end surfaces, to obtain the total deduction percentage
- no end-surface defect will be considered to affect less than 10% of one end of a log

6. GRADING PROCEDURES

- establish log position (i.e. butt or upper log)
  - in skidways, a butt log must show evidence of having been removed from the stump (i.e. notch, undercut, root swell, stump pull or selection harvest paint markings).
  - at slasher sites or landings, where scalers are able to see the logs being slashed, the above evidence will not be necessary.
- measure the gross diameter at the small end of the log
- determine the preliminary grade of the log from these observations
- assess the entire log to determine the total percentage of defect
- set the final grade of the log

Figure 27 represents a sound maple butt log, 4.3 metres in length. The log measures 36 centimetres in diameter at the small end. Since this is a butt log with a small end diameter greater than 24 centimetres, it is a grade 1 log.

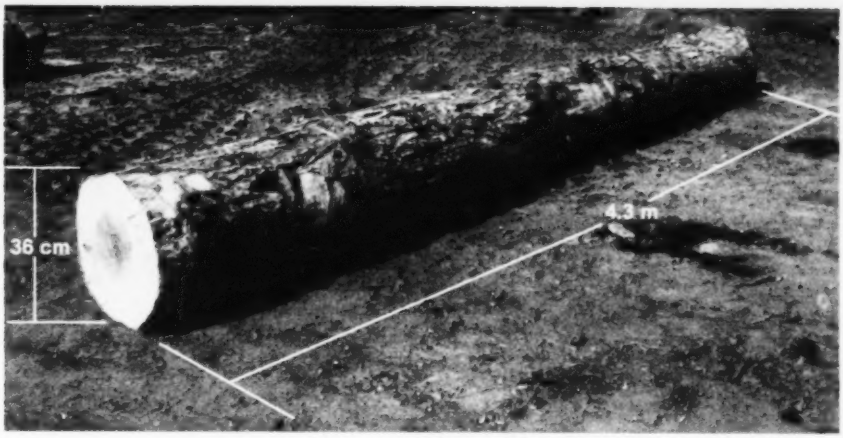


Figure 27 - A grade 1 maple butt log

Figure 28 represents a sound oak upper log, 3.1 metres long and measuring 28 centimetres at the small end. Since this is an upper log with a small end diameter less than 30 centimetres, it is a grade 2 log.

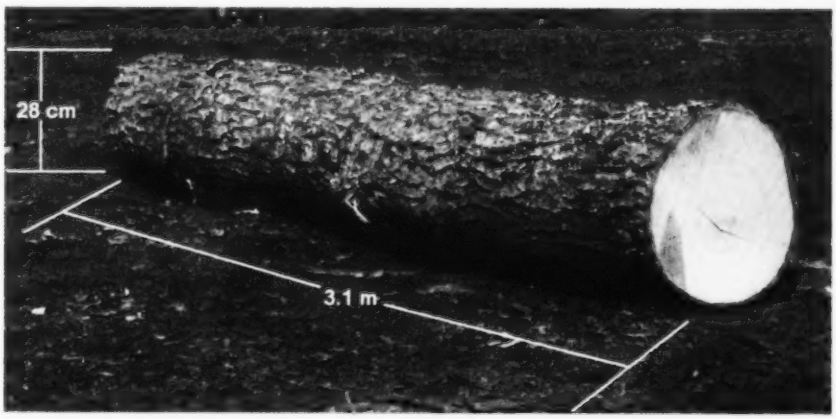


Figure 28 - A grade 2 oak upper log

7. DEFECTS

Heart rot, stump rot, heart check, shake and punk rot as described in the Cubic Method, Part A, ection 4 (Defects), are also applicable to graded hardwoods.

Defects are classified as either partial or continuous. Partial defects are those that appear on only one end of a log. It is assumed they extend halfway through the log. Continuous defects are those that appear on both ends of a log. They are assumed to extend through the entire length of the log.

Seams, shake and rot may be either partial or continuous defects. Individual deductions are made on a percentage basis as 10%, 25%, 33⅓%, 50%, 66⅔% or 100%.

Crook and sweep are considered continuous defects, and the deductions are 10%, 25%, 33⅓% or 50% of the whole log.

The minimum percentage deduction for a log is 10%.

(a) Culls

Any log having **more than two-thirds (66⅔%) of its volume defective** is considered a **cull log**. Culls are indicated by a distinct mark (e.g. "X", the word "Cull", etc.) on the sawn surface and are tallied by species and piece.

(b) Partial defects

When a defect is encountered in one end of a log, the scaler estimates the percentage of defect on the sawn surface being assessed. Since the defect is assumed to extend half way through the log, this percentage is divided by 2 to obtain the necessary deduction for the log.

Example 1: A log having a defect affecting 10% of one end will require a 10% deduction of the whole log. The deduction is $\frac{10}{2}$ = **5%**.

Since the minimum deduction in grading is 10% we record a **10% deduction** of the whole log.

Example 2: A log contains a defect affecting 25% of one end. The deduction is $\frac{25}{2}$ = **12½% deduction** of the whole log.

Example 3: A log contains a defect affecting 50% of one end. The deduction is $\frac{50}{2}$ = **25% deduction** of the whole log.

Example 4: A log containing a defect affecting more than 66⅔% of one end is considered to have a cull end. The deduction is $\frac{100}{2}$ = **50% deduction** of the whole log.

Figure 29 represents a maple upper log, 2.5 metres in length, which measures 40 centimetres on the small end. Since it is an upper log with a small end diameter greater than 30 centimetres, the preliminary grade is 1. It contains a defect in the top end that affects 10% of that end. Since the defect affects 10% of one end only, the total deduction for the log will also be 10%. This log will remain a grade 1.

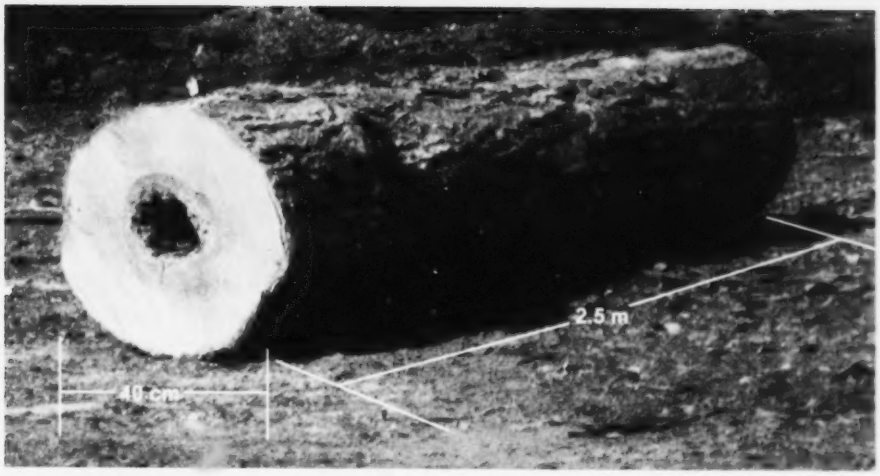


Figure 29 - A grade 1 maple upper log containing a defect

Figure 30 represents an oak upper log, 2.5 metres in length that measures 40 centimetres in diameter at the small end. This log is a preliminary grade 1. It contains a defect that affects 50% of the butt end. Since the defect is in one end only, the estimated percentage must be divided by 2; this equals 50% ÷ 2 = **25% deduction** of the whole log.

Since grade 1 logs can be up to and including 25% defective, the log remains a grade 1.

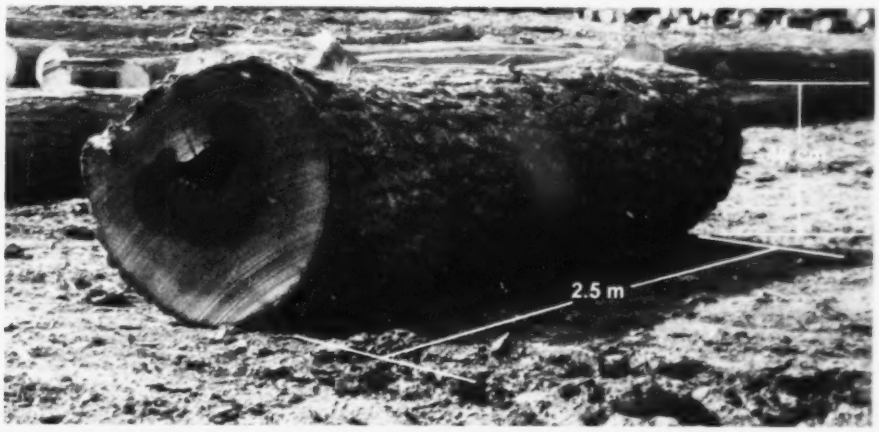


Figure 30 - A grade 1 oak upper log containing a defect

Figure 31 represents a beech upper log, 3.9 metres in length that measures 32 centimetres in diameter at the small end. This log is a preliminary grade 1. It contains a defect in the larger end big enough to cull that end (100% deduction). Since the defect is in one end only, the estimated percentage deduction must be divided by 2; this equals 100% ÷ 2 = **50% deduction** of the whole log.

Since grade 1 log defect cannot exceed 25%, the log is a grade 2.

Figure 31 - A grade 2 beech upper log containing a defect

(c) Continuous Defects

When defects are encountered in both ends of a log, the scaler estimates the percentage of defect in each end. These percentages are added together and divided by 2 to obtain the necessary percentage of defect to determine the log grade.

Example 1: A log has a 25% deduction in one end and a 10% deduction at the other end. The percentage of defect used to determine the log grade is $\frac{(25 + 10)}{2} = \frac{35}{2} =$ **17½% deduction** of the whole log.

Example 2: A log has a 25% deduction in one end and a 25% deduction at the other end. The percentage of defect used to determine the log grade is $\frac{(25 + 25)}{2} = \frac{50}{2} =$ **25% deduction** of the whole log.

Example 3: A log contains a 50% deduction at one end and a 10% deduction at the other end. The percentage of defect used to determine the log grade is $\frac{(50 + 10)}{2} = \frac{60}{2} =$ **30% deduction** of the whole log.

Example 4: A log contains a 50% deduction at one end and a 25% deduction at the other end. The percentage of defect used to determine the log grade is $\frac{(50 + 25)}{2} = \frac{75}{2} =$ **37½% deduction** of the whole log.

Example 5: A log contains one cull end and a 50% deduction at the other end. The percentage of defect used to determine the log grade is $\frac{(100 + 50)}{2} = \frac{150}{2} =$ **75% deduction** of the whole log.

Since the log is **more than 66⅔ defective,** the log is considered a **cull**.

Figure 32 represents a maple butt log 3.7 metres in length and measuring 36 centimetres at the small end. This log is a preliminary grade 1. It contains a defect (seam and rot) in the butt end affecting 25% of that end. It also contains a defect in the top end that affects 10% of that end. The percentage of defect used to determine the log grade is

$$\frac{(25 + 10)}{2} = \frac{35}{2} = \underline{\textbf{17½ \% deduction}} \text{ of the whole log.}$$

Since the total defect percentage is less than 25% it would remain a grade 1 maple log.

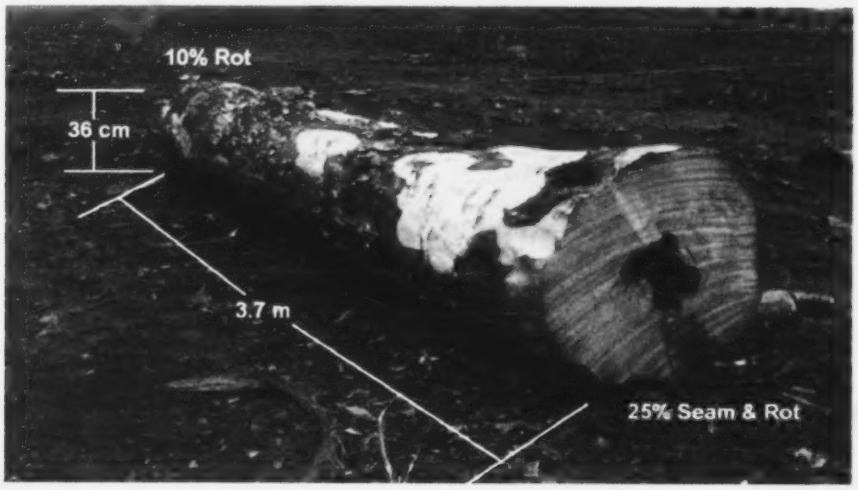


Figure 32 - A grade 1 maple butt log containing a defect

(d) Seams or Lightning Scars

Seams or lightning scars are other common defects that affect log grade. They may extend straight along the outside of the log or have a spiral shape. In either case, they generally penetrate the wood to some depth, reducing lumber yield. The scaler must estimate the percentage of the log that is affected. The scaler must consider the natural taper of the log and the normal slab when assessing seams. **Seams that will be eliminated in the manufacturing process are not considered defects.**

If a seam or seams appear **in one end of a log only**, they will be considered as partial defects. The scaler estimates the percentage of defect in relation to the whole end. This percentage is divided by 2 to obtain the percentage of defect necessary to determine the log grade (see Figure 33).

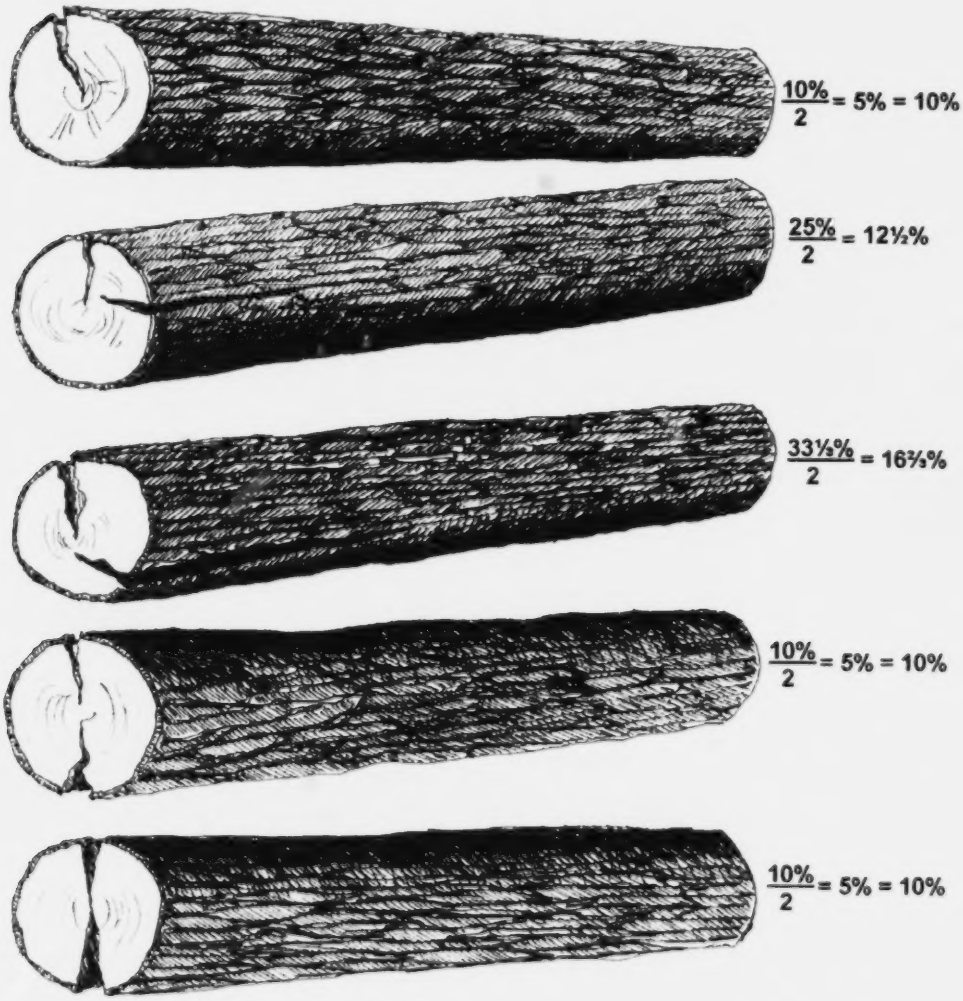


Figure 33 - Various seams with the required percentage deductions

If the same seam or related seams appear in both ends of a log, they will be considered continuous defects, and the percentage deduction necessary for the whole log determined. **This deduction will not be divided by 2** (see Figure 34).

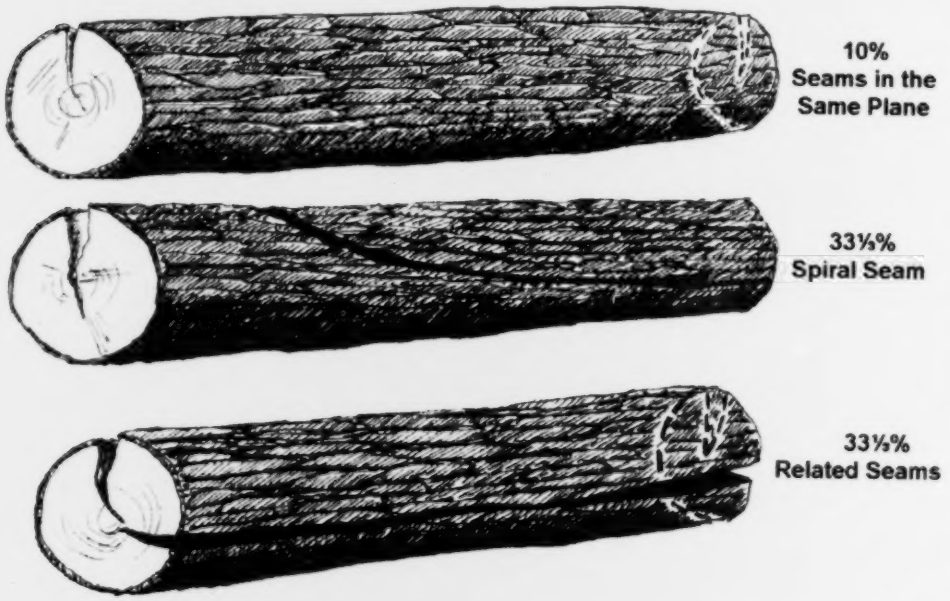


Figure 34 - The required percentage deductions

If **unrelated seams** in the **same plane** appear on both ends of the log, they will be considered as partial defects which are added together and divided by 2 (see Figure 35).

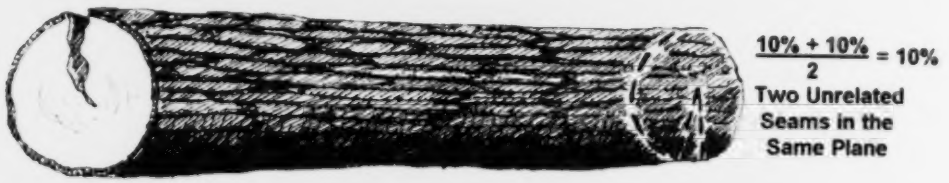


Figure 35 - The required percentage of deductions for the log where two unrelated seams are in the same plane

If **unrelated** seams appear **in different planes** on both ends of a log, the necessary percentage deduction for **each** end of the log **are added together**. **The total is not divided by 2.** Since both seams are in **different planes** and impact the yield of lumber from each plane, two separate deductions are required (see Figure 36).

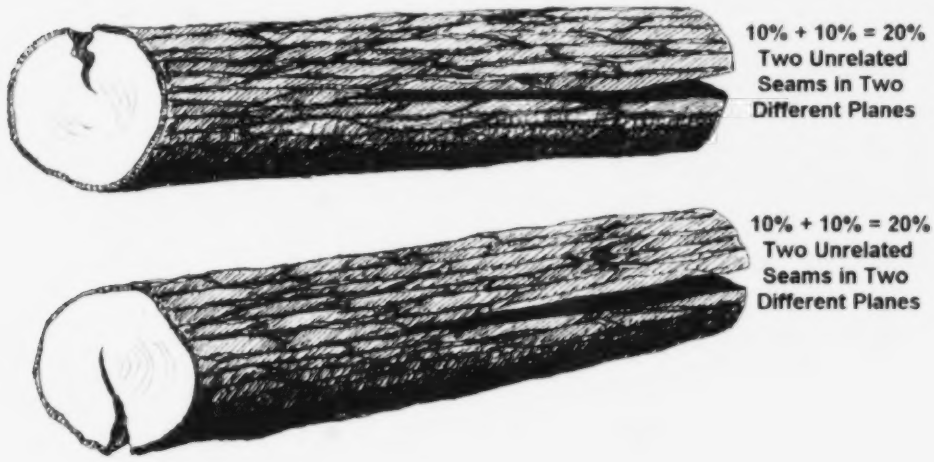


Figure 36 - The required percentage of deductions for the log where two unrelated seams are in different planes

(e) Crook or Sweep

In order to make deductions for crook or sweep, the scaler must estimate the percentage of the log that will be lost in the lumber manufacturing process. An imaginary line is extended along the longest straight section of the log, on the inside of the crook or sweep, to determine where this line bisects the other end of the log.

When the log has been aligned, and the imaginary line bisects the opposite end of the log at a point up to and including the centre of that end, the required deduction will be 10% (see Figure 37).

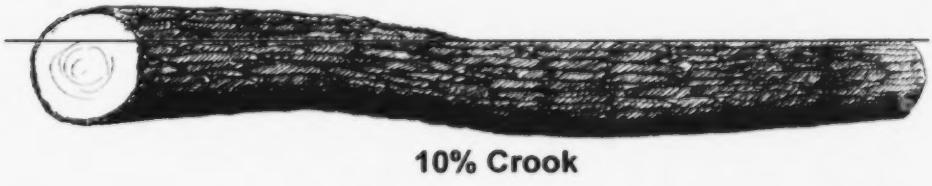


Figure 37 - Illustration of a 10% crook

When the imaginary line bisects the opposite end of the log at a point beyond the centre of the log, but not completely off the end, the required deduction will be 25% (see Figure 38).

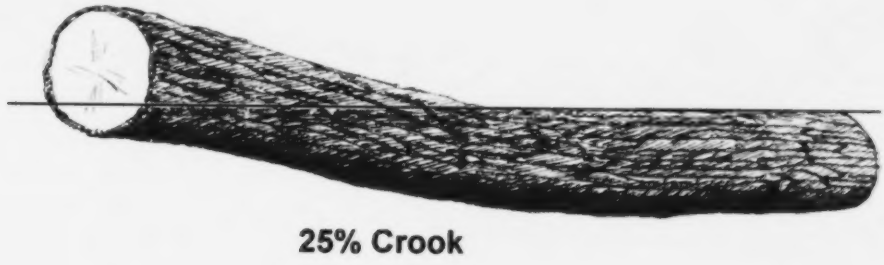


Figure 38 - Illustration of a 25% crook

When the imaginary line cuts off the other end of the log at a point 30 centimetres or less from the sawn surface, the required deduction will be 33⅓% (see Figure 39).

Figure 39 - Illustration of a 33⅓% crook

When the imaginary line cuts off the other end of the log at a point greater than 30 centimetres from the sawn surface, the required deduction will be 50% (see Figure 40).

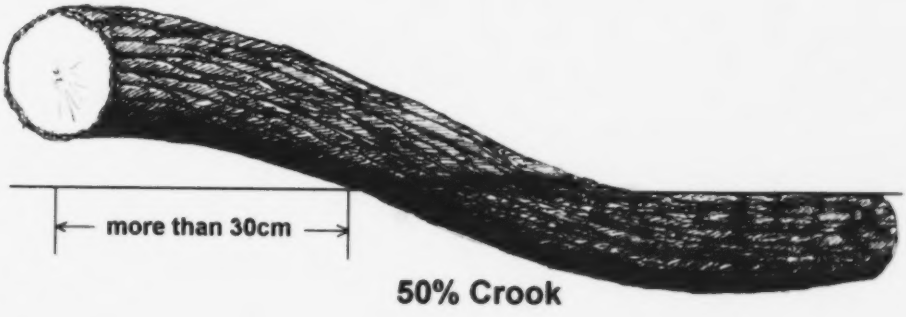


Figure 40 - Illustration of a 50% crook

More severe crooks or sweeps will require a 50% deduction (see Figure 41).

Figure 41 - Illustration of a serious crook or sweep requiring 50% deduction

When a crook appears in one end of a log and rot is contained in the other end, the crook is a continuous defect and the rot a partial defect. It is necessary to calculate the total percentage of defect affecting the log in order to determine the grade.

Example 1: A hardwood log contains a crook in the top end affecting 25% of the log, and a rot in the butt end affecting 66⅔% of the butt (see Figure 42). The total percentage of the log affected is

$$25 + \frac{(66\frac{2}{3})}{2} = 25 + 33\frac{1}{3} = \underline{\mathbf{58\frac{1}{3}\%\ deduction}}$$ of the whole log.

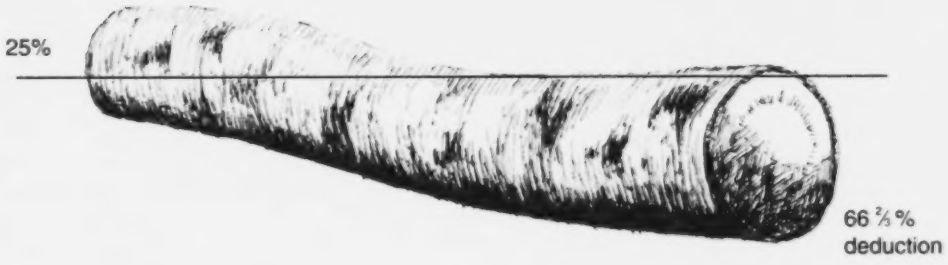


Figure 42 - Illustration of crook and rot

Example 2: A hardwood log contains a crook in the top end affecting 10% of the log, and a rot in the butt end affecting 10% of the butt (see Figure 43). The total percentage of the log affected is

$$10 + \frac{(10)}{2} = \underline{\mathbf{15\%\ deduction}}$$ of the whole log.

Figure 43 - Illustration of crook and rot

If a rot or defect appears at one end of a log and a crook or sweep in the log completely cuts off this rot or defect, **then the percentage deduction for the rot or defect is disregarded** (see Figure 44).

Figure 44 - Illustration of crook cutting off rot

If a rot or defect more than **10 centimetres** in diameter appears on one end of a log, and a crook in the log partially cuts off this rot, then a percentage deduction of 10% or 25% for crook or sweep **will be increased** to the next highest deduction. When a 33⅓% or 50% deduction for crook is made, no further increase will be necessary.

Example 3: If a 10% deduction is necessary for crook and if a 14 centimetre defect in one end of the log is partially cut off by the crook, the percentage deduction of 10% will be raised to 25% (see Figure 45).

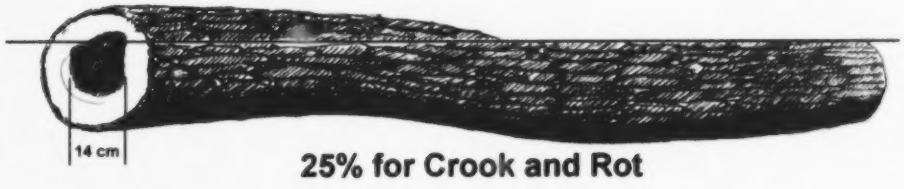
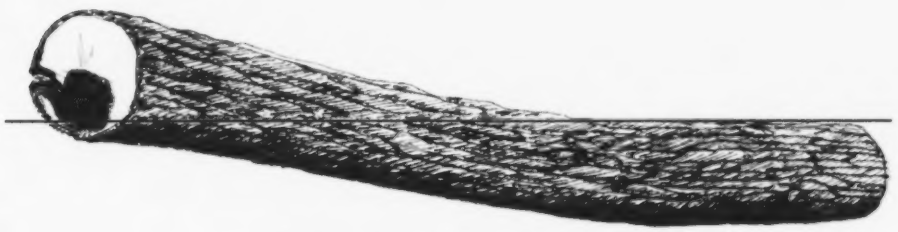


Figure 45 - Illustration of defect partially cut off by a 10% crook

Example 4: If a 25% deduction is necessary for crook and if a 12 centimetre defect in one end of the log is partially cut off by the crook, the percentage deduction of 25% will be raised to 33⅓% (see Figure 46).



33⅓% Crook, Seam and Rot

Figure 46 - Illustration of defect partially cut off by a 25% crook

Example 5: If a 33⅓% or 50% deduction is necessary for crook, and a defect greater than 10 centimetres appears in the end of the log that was entirely cut off by the crook, **no further increase is necessary** (see Figure 47).

33⅓% for Crook and Rot

Figure 47 - Illustration of defect completely cut off by a 33⅓% crook

8. UNDERSIZE

In the cube grade method, undersize is defined as:

- hardwoods, other than poplar and white birch, that have a gross diameter less than 20 centimetres (diameter class).

9. FIELD APPLICATION OF CUBE GRADE METHOD

Cube grade method is applied as follows:

(a) When individual logs are encountered, measure **both ends of the log** to obtain the mean diameter. **The whole log (log position, small end diameter and total percentage of defect) is used for grading purposes.** The scaler records

species, length and mean diameter by grade **for each log**. **Each log will be marked with an "S" and the assigned grade.**

(b) When a skidway or load of logs is encountered, diameters are measured from **one side of the skidway or load**, provided there is an even distribution of large and small ends on each side. These diameters will be used for volume calculation. **The whole log (log position, small end diameter and total percentage of defect) is used for grading purposes**. The scaler records species, length and diameter by grade **for each log. The measured end will be marked with an "S" and the assigned grade.**

(c) When a **factor for grade distribution** is to be applied, diameters are measured from **one side of the skidway or load**, provided there is an even distribution of large and small ends on each side. These diameters will be used for volume calculation. The scaler records species, length and diameter **for each log**. Factors for grade distribution are applied using the Ministry's volume and value calculation computer software. Prior approval is required from the **Ministry's Regional Measurement Coordinator** before measurement occurs in this manner. **The measured end will be marked with an "S".**

10. IDENTIFICATION OF SKIDWAYS

When skidways or groups of skidways are measured, the scaler must place the following information on the end of one or more conspicuous logs:

- skidway number
- date
- scaler's initials
- any other information requested by the **Ministry's Regional Measurement Coordinator**

Skidways are numbered consecutively for each **Approval to Commence Harvesting Operations**. Closely situated skidways may be tallied together, provided the total number of **measured logs does not exceed 1,000**. These are known as groups of skidways, and they must be properly identified. **This grouping must not occur without prior approval from the Ministry's Regional Measurement Coordinator.**

E. MASS METHOD

All conifer, poplar and white birch of all lengths, as well as graded hardwoods, chip fibre and fuelwood, may be measured by this method. Units of mass are converted to units of volume by using mass/volume ratios developed for each species.

Manned or unmanned weigh scales are acceptable means of measuring provided they meet Ministry of Natural Resources standards. The Ministry's Regional Measurement Coordinator, in consultation with the appropriate industry representatives, must ensure scale operations meet all regulatory requirements.

Weighing devices, their manufacture, installation and use are regulated by the Weights and Measures Act of Canada. The Act states that all weighing devices must be approved and certified prior to use and that any commodity, traded on the basis of weight, must be measured within the prescribed limits of error as defined in the Regulations.

The Weights and Measures Act specifies those regulations pertaining to:

- the design, configuration and construction of weighing devices
- installation and use
- their performance

The minimum facility standards for mass measuring Crown forest resources are listed in Ministry procedure (FOR 05 05 61).

The Provincial Measurement Supervisor must approve all exceptions to the minimum facility standards.

All weighing devices will be operated within the standards as specified in the Weights and Measures Act. Scales will be maintained in good operating condition. The deck must be kept clear of ice, snow and other material that may accumulate during the hauling operation. When mass measuring is in progress the scale must be adjusted to read zero mass after each transaction.

1. UNIT OF MEASUREMENT

Kilogram

2. MEASURING PROCEDURE

To mass measure Crown forest resources for Crown purposes, the weigh scale facility must conduct measuring procedures in the following manner:

- The weigh scale facility must be approved to measure unscaled Crown forest resources and the Company must have a Mass Scaling Agreement with the Crown.

- The licensee must acquire a valid Authority to Haul Unscaled Crown Forest Resources which has been approved by the **Ministry's Regional Measurement Coordinator prior to movement of the Crown forest resources**.

- The weigh scale facility must be in possession of a copy of this Authority to Haul Unscaled Crown Forest Resources (or interim approval from the Ministry's Regional Measurement Coordinator or Provincial Measurement Supervisor), before measuring and processing of scale returns occurs.

- A completed **bill of lading** will accompany each load of unscaled Crown forest resources to the weighing location.

- The gross mass (weight of tractor, trailer and load) and the tare mass (weight of the tractor and empty trailer) **will be measured and recorded for each load.**

- Every tractor and empty trailer must be weighed to determine its tare mass **after the delivery of each load**.

- If the gross mass includes the weight of the driver, then the tare mass must also include the weight of the driver.

- The tractor and empty trailer **must not be cleaned** of debris between the gross and tare measurements.

- The tractor **must not be refuelled** between gross and tare measurements.

- The net mass of the load is determined by subtracting the tare mass of the empty vehicle from the gross mass of the loaded vehicle.

- A mass scale slip/ticket, which is numbered consecutively and displays all information required for the identification of the load, will be produced.

- Vehicles used for hauling Crown forest resources to a weigh scale facility must be properly identified and the information recorded on the mass slip/ticket (e.g. truck licence plate number, truck owner/number, etc.).

- The weigh scale facility will maintain a record of all mass measured transactions in a manner approved by the **Ministry's Regional Measurement Coordinator**.

- A schedule will be implemented for the timely submission of mass measure transactions to the Crown.

Note: **Where the deck of the weigh scale is not long enough to accommodate the entire length of the tractor and trailer, the driver will place the entire trailer on the scale deck, detach the tractor from the trailer, and remove the tractor from the deck prior to both (gross and tare) measurements.**

The practice of combining separate (split) axle weights to determine the gross mass or the tare mass is **not permitted**.

Where the weighing device becomes inoperable, an alternate method of measurement, as defined in the Mass Scaling Agreement, **will be implemented**.

3. CALCULATION OF VOLUME

On mass measuring operations, for each Approval to Commence Harvesting Operations, the following must be determined annually:

- for all **conifers, poplar and white birch**: factors for species distribution, undersize deduction, defect deduction and product(s)
- for **graded hardwoods**: factors for species distribution, grade distribution, undersize deduction, cull log deduction and product(s)
- for **white and red pine**: factors for species distribution, undersize deduction, defect deduction, category (grade) distribution and product(s)

Applying factors to determine volume:

- Each species has its own mass/volume ratio, derived from the Ministry's sampling program that converts the mass of the load from kilograms to solid cubic metres.
- For single species (pure) loads, calculate the gross volume of the load using the mass/volume ratio for that species.
- For mixed species loads, a blended mass/volume ratio must be determined for the load prior to the calculation of gross volume.
- For mixed species loads, the species distribution factor is applied to determine the gross volume by species.
- For mixed grade species, the grade distribution factors are applied to determine gross volume by species and grade.
- For white and red pine, the category (grade) distribution factors are applied to determine gross volume by species and category.
- For a load distributed to multiple destinations, the destination distribution factors are applied to determine gross volumes by species, destination and grade or category if required.
- The undersize factor is applied to the gross volume for each species **prior to applying** defect factors.

- The net volume is determined by applying the defect factor to the sum of the gross volume less undersize.

- Volumes are expressed in cubic metres correct to three (3) decimal places.

When loads of Crown forest resources, that are mass measured, contain more than one species, the percentage of each species will be determined and applied on a **harvest approval basis**. Sampling data should be used to determine species breakdown. Until sampling data is available, current operational cruising information, accurate pre-cut inventory data (e.g. forest resource inventory), or historical scaling data may be used.

Example 1: Determining the **gross volume** of a single species (pure) load.

A load of jack pine logs is delivered to a mass measuring site:

Gross weight is 62,780 kgs
Tare weight of the tractor and trailer is 20,490 kgs.
For this example the mass/volume ratio for jack pine is 808 kgs per cubic metre of solid wood.

Step # 1

Calculate the net weight of the load:

Gross weight	62,780 kgs
Tare weight	- 20,490 kgs
Net weight of load	42,290 kgs

Net weight of load is **42,290 kgs.**

Step # 2

Calculate gross solid cubic metres of jack pine in the load:

42,290 kgs ÷ 808 kg/m^3 = 52.3391 = 52.339 m^3 (correct to 3 decimal places)

Gross volume of jack pine is **52.339 m^3**.

Example 2: Determining the **net volume** of a single species (pure) load.

To determine the net volume of the load, the undersize and defect, if applicable, must be deducted from the gross volume. Using the gross volume from Example 1, apply an undersize factor of 3.1% and a defect factor of 7.5% to calculate net volume.

Step # 1

Reduce the volume of the load by removing the **undersize material**:

Gross volume is 52.339 m^3
Undersize factor is 3.1%
Factor to calculate gross volume less undersize 100% - 3.1% = 96.9% or 0.969
Gross volume less undersize = 52.339 x 0.969 = 50.716491
= **50.716 m^3** (correct to three decimal places)

Step # 2

Further reduce the volume by removing the **defect material** to determine the net volume:

Defect factor is 7.5%
Factor to calculate volume less defect 100% - 7.5% = 92.5% or 0.925
Net volume = 50.716 x 0.925 = 46.9123
= **46.912 m^3** (correct to three decimal places)

Therefore the **net volume** of the load is **46.912 m^3.**

Example 3: Determining a **blended mass/volume ratio** from a multiple species (mixed) load.

When more than one species is mass measured, a blended mass/volume ratio must be calculated for the species distribution.

For this example:

48% of the load is jack pine and the mass/volume ratio is 808 kgs/m^3
37% of the load is spruce and the mass/volume ratio is 763 kgs/m^3
15% of the load is balsam fir and the mass/volume ratio is 791 kgs/m^3

Species distributions must equal 100% = 48 + 37 + 15 = 100%

Jack pine = 808 kgs x 48% = 808 x 0.48 = 387.84 rounded to nearest whole kg = **388 kgs**

Spruce = 763 kgs x 37% = 763 x 0.37 = 282.31 rounded to nearest whole kg = **282 kgs**

Balsam fir = 791 kgs x 15% = 791 x 0.15 = 118.65 rounded to nearest whole kg = **119 kgs**

Blended mass/volume ratio for this species distribution example is:
388 + 282 + 119 = **789 kgs/m^3.**

Example 4: Determining the **gross volume by species** from a multiple species (mixed) load.

Apply the species mix from Example 3 (jack pine (48%), spruce (37%) and balsam fir (15%)) to a load with a net weight of 39,730 kgs.

Step # 1

Calculate the volume of the load in gross cubic metres:

39,730 kgs ÷ 789 kgs per cubic metre = 50.354879 = 50.355 m^3

Gross volume of the load is **50.355m^3**.

Step # 2

Calculate the gross volume in cubic metres by species:

Jack pine = 50.355 m^3 x 48% or 0.48 = 24.1704 = **24.170 m^3**

Spruce = 50.355 m^3 x 37% or 0.37 = 18.63135 = **18.631 m^3**

Balsam fir = 50.355 m^3 x 15% or 0.15 = 7.55325 = **7.553 m^3**

Example 5: Determining the **net volume by species** from a multiple species (mixed) load.

To determine the net volume for each species in the load, the undersize and defect, if applicable, must be deducted from the gross volume for each species.

Using the gross volumes obtained from Example 4:

Jack pine
Gross volume is 24.170 m^3 which contains undersize of 0.9% and defect of 4.8%.

Undersize factor is 0.9%
Factor to calculate gross volume less undersize 100% - 0.9% = 99.1% or 0.991
Gross volume less undersize = 24.170 x 0.991 = 23.95247 = **23.952 m^3**

Defect factor is 4.8%
Factor to calculate volume less defect 100% - 4.8% = 95.2% or 0.952
Net volume = 23.952 x 0.952 = 22.802304 = 22.802 m^3

Therefore the **net volume of jack pine** for the load is **22.802 m^3**.

Spruce
Gross volume is 18.631 m^3 which contains undersize of 5.5% and a defect of 3.3%.

Undersize factor is 5.5%
Factor to calculate gross volume less undersize 100% - 5.5% = 94.5% or 0.945
Gross volume less undersize = 18.631 x 0.945 = 17.606295 = **17.606 m^3**

Defect factor is 3.3%
Factor to calculate volume less defect 100% - 3.3% = 96.7% or 0.967
Net volume = 17.606 x 0.967 = 17.025002 = 17.025 m^3

Therefore the **net volume of spruce** for the load is **17.025 m^3**.

Balsam fir
Gross volume is 7.553 m^3 which contains undersize of 4.0% and a defect of 5.7%.

Undersize factor is 4.0%
Factor to calculate gross volume less undersize 100% - 4.0% = 96.0% or 0.960
Gross volume less undersize = 7.553 x 0.960 = 7.25088 = **7.251 m^3**

Defect factor is 5.7%
Factor to calculate volume less defect 100% - 5.7% = 94.3% or 0.943
Net volume = 7.251 x 0.943 = 6.837693 = 6.838 m^3

Therefore the **net volume of balsam fir** for the load is **6.838 m^3**.

Example 6: Determining the **net volume by destination and species** for a multiple species (mixed) load.

A mixed load of poplar and white birch logs is delivered to a mass measuring site:

Gross weight is 63,510 kgs.
Tare weight of the tractor and trailer is 21,470 kgs.

For this example the mass/volume ratio for:
- poplar is 918 kgs per cubic metre of solid wood
- white birch is 1063 kgs per cubic metre of solid wood

From sampling, it has been determined that species distribution is:
- 69% of the load is poplar
- 31% of the load is white birch

Species distributions must equal 100% = 69% + 31% = **100%**

From sampling, it has been determined that destination split is:

Poplar
- 82% of the gross poplar volume is delivered to a composite mill
- 18% of the gross poplar volume is delivered to a veneer mill

Destination distributions must equal 100% by species
= 82% + 18% = **100%**

White Birch
- 77% of the gross white birch volume is delivered to a composite mill
- 23% of the gross white birch volume is delivered to a veneer mill

Destination distributions must equal 100% by species
= 77% + 23% =**100%**

From sampling, it has been determined that the undersize and defect factors by product sector are:

Poplar
Undersize to a composite mill is 12.3%
Defect to a composite mill is 8.4%

Undersize to a veneer mill is 0.0%
Defect to a veneer mill is 2.0%

White Birch
Undersize to a composite mill is 15.3%
Defect to a composite mill is 5.4%

Undersize to a veneer mill is 0.0%
Defect to a veneer mill is 1.0%

Using the above information:

Step # 1

Calculate the **net weight** of the load:

Gross weight	63,510 kgs
Tare weight	– 21,470 kgs
Net weight	42,040 kgs

The net weight of the load is **42,040 kgs.**

Step # 2

A **blended mass/volume ratio** must be calculated for the species distribution.

Poplar is 918 kgs x 69% = 918 x 0.69 = 633.42 rounded to nearest whole kg = **633 kgs**

White birch is 1063 kgs x 31% = 1063 x 0.31 = 329.53 rounded to nearest whole kg = **330 kgs**

The blended mass/volume ratio for this species distribution example is 633 + 330 = **963 kgs/m^3**.

Step # 3

Calculate the **gross solid cubic** metres for the load:

42,040 kg ÷ 963 kg/m^3 = 43.655244 = **43.655 m^3**

The gross solid cubic metres are **43.655 m^3**.

Step # 4

Calculate the **gross cubic metres by species**:

Poplar = 43.655 m^3 x 69% or 0.69 = 30.12195 = **30.122 m^3**

White birch = 43.655 m^3 x 31% or 0.31 = 13.53305 = **13.533 m^3**

Step # 5

Calculate the **gross cubic metres by species and destination**:

Poplar
Poplar to the composite mill:
30.122 m^3 x 82% or 0.82 = 24.70004 = **24.700 m^3**

Poplar to the veneer mill:
30.122 m^3 x 18% or 0.18 = 5.42196 = **5.422 m^3**

White Birch
White birch to the composite mill:
13.533 m^3 x 77% or 0.77 = 10.42041 = **10.420 m^3**

White birch to the veneer mill:
13.533 m^3 x 23% or 0.23 = 3.11259 = **3.113 m^3**

Step #6

Calculate the **net cubic metres by species and destination**:

Poplar
Poplar to the composite mill:

Gross volume is 24.700 m^3
Undersize factor is 12.3%
Factor to calculate gross volume less undersize 100% - 12.3% = 87.7% or 0.877
Gross volume less undersize = 24.700 x 0.877 = 21.6619 = **21.662 m^3**

Defect factor is 8.4%
Factor to calculate volume less defect 100% - 8.4% = 91.6% or 0.916
Net volume = 21.662 x 0.916 = 19.84239 = 19.842 m^3

The net volume of poplar to the composite mill is 19.842 m^3.

Poplar to the veneer mill:

Gross volume is 5.422 m^3
There is no undersize deduction.

Defect factor is 2.0%
Factor to calculate volume less defect 100% - 2.0% = 98.0% or 0.980
Net volume = 5.422 x 0.980 = 5.31356 = **5.314 m^3**

The net volume of poplar to the veneer mill is 5.314 m^3.

White Birch
White birch to the composite mill:

Gross volume is 10.420 m^3

Undersize factor is 15.3%
Factor to calculate gross volume less undersize 100% - 15.3% = 84.7% or 0.847
Gross volume less undersize 10.420 x 0.847 = 8.82574 = **8.826 m^3**

Defect factor is 5.4%
Factor to calculate volume less defect 100% - 5.4% = 94.6% or 0.946
Net volume is 8.826 x 0.946 = 8.349396 = 8.349 m^3

The net volume of white birch to the composite mill is 8.349 m^3.

White birch to the veneer mill:

Gross volume is 3.113 m^3
There is no undersize deduction.

Defect factor is 1.0%
Factor to calculate volume less defect 100% - 1.0% = 99.0% or 0.990
Net volume is 3.113 x 0.990 = 3.08187 = 3.082 m^3

The net volume of white birch to the composite mill is <u>3.082 m^3</u>.

4. IDENTIFICATION OF LOAD

Each mass scale slip must show the following information:

- bill of lading number
- mass scale slip number
- Approval to Commence Harvesting Operations number (Harvest Approval)
- gross mass of loaded vehicle in kilograms
- tare mass of empty vehicle in kilograms
- net mass of load in kilograms
- date
- species
- mass measuring location
- final destination of load (destination code)
- truck identification (e.g. Licence plate number, trucker's name)
- scale operator
- any other information requested by the **Ministry's Regional Measurement Coordinator**

F. STANDING TREE METHOD

Standing tree measurement is the measurement of standing trees prior to harvesting.

1. APPLICATION

This method of measurement may only be used in one of the following situations:

- for access and utility corridors (e.g. road right of way, hydro lines, etc.)
- for sale of timber reserved to the Crown on patented land
- forest resource licences of 25 hectares and less
- remote sites where the timber will not be utilized (e.g. remote airstrips, tower sites, etc.)

This method of measurement should not be used where other more cost effective and accurate methods of measurement are available. **The measuring procedures and the standing tree volume tables must be approved by the Ministry's Regional Measurement Coordinator.**

2. UNIT OF MEASURE

Cubic metre

3. MEASURING PROCEDURE

Diameters of all trees are measured at **breast height** (1.4 m above ground level) **outside the bark** in **two centimetre** size class intervals, with the class boundary occurring on the odd centimetre and recorded in even centimetre classes. **A diameter that coincides with the class boundary of two size classes belongs to the lower size class**. Diameters are recorded by species and product or destination. Calipers are used to measure diameters.

The height of individual trees or stands is to be determined by a method approved by the **Ministry's Regional Measurement Coordinator** and recorded in metres correct to one decimal place.

Where a sampling procedure is to be applied, it must be approved by the **Ministry's Regional Measurement Coordinator**.

4. CALCULATION OF VOLUME

Volume is determined by using volume tables and defect factors approved by the **Ministry's Regional Measurement Coordinator**.

G. OTHER MEASUREMENT APPLICATIONS

1. SUNKEN LOGS

This applies to the measurement of logs that have been retrieved from water bodies for commercial purposes (e.g. logs for resale or logs to be processed into commercial products). The outward appearance of some of these logs may be deceiving in terms of their true quality and value.

Sunken or submerged logs are considered the property of the Crown where the lake or river bed they occupy is Crown land.

A) UNIT OF MEASURE

Cubic metre

B) MEASURING PROCEDURE

Gross diameters are measured in **2 centimetre** size classes (as previously described under diameters in Section III (A), Cubic Method). The use of calipers may be necessary where the end surfaces of the logs have been altered through water action or decay.

Lengths are measured in **metres and 20 centimetre size classes** (as previously described under lengths in Section III (A), Cubic Method) using the **merchantable length of each log**. Lengths are reduced where end surfaces have been rounded or indented due to water action and decay. **The maximum length that may be measured and recorded is 5.7 metres**. If the log length is greater than 5.7 metres, it must be measured and recorded in two or more sections.

When identifiable, the species of the logs are to be recorded. If the species of the logs are impossible to identify, the scaler shall record them as "**All Species**".

Logs must be piled in a suitable fashion for measurement with both ends exposed.

Where the log quality does not permit the normal application of the Scaling Manual, the Ministry's Regional Measurement Coordinator will establish the measurement procedure following the principles in this Manual.

C) CALCULATION OF VOLUME

Volumes will be calculated in solid cubic metres, as described in Section III (A), (Cubic Method), "Calculation of Volumes". **Sunken hardwood logs are not graded.**

There are no deductions for defect, undersize or cull logs when measuring sunken logs.

2. FUELWOOD

All Crown forest resources used for fuelwood are subject to stumpage charges.

Hardwood and conifer fuelwood may be measured by any one of the following methods:

- cubic method
- tree length method
- stacked method (for wood up to and including 2.80 metres in length)
- mass method (fuelwood may not be mixed with other timber before mass measuring without prior approval of the **Ministry's Regional Measurement Coordinator**)

There are no deductions for undersize, defect or cull logs when measuring fuelwood.

3. CONSTRUCTION TIMBER

Construction timber is any timber used for skids, corduroy or any construction work such as camps, bridges or roads on a logging operation. This would include timber harvested for such purposes but not utilized.

All Crown forest resources used as construction timber are subject to stumpage charges.

Any applicable method of measurement in this Manual may be used to scale construction timber.

The scaler will record construction timber by species, length and diameter class on a tally sheet separate from other Crown forest resources.

There are deductions for undersize, defect and cull logs when measuring construction timber.

4. SALVAGE TIMBER

Salvage timber is defined as:

> *Killed or damaged forest resources that have been affected by the natural causes of wind, fire, flood, insects or disease.*

All Crown forest resources harvested on salvage operations are subject to stumpage charges.

Any applicable method of measurement in this Manual may be used to scale Crown forest resources originating from licenced salvage operations.

There are no deductions for undersize, defect or cull logs when measuring salvage timber.

Wasteful practice standards will not be applied on salvage operations unless approved by the Ministry's Regional Measurement Coordinator.

H. SAMPLE SCALING

1. APPLICATION OF SAMPLE SCALING

The principle of sample scaling is that certain characteristics of a large group of similar items can be determined as accurately from a small sample of those items as from measuring the entire group. For example, when sample scaling, only a small proportion of timber piled in a skidway is measured. This measured sample is used to determine the total volume of the skidway. The emphasis is on the **care of measurement** and **the unbiased selection of the measured sample.**

With the approval of the **Ministry's Regional Measurement Coordinator,** sample scaling may be applied to the measurement of timber on harvesting operations producing **more than 25,000 pieces**.

A sample scaling procedure must be applied carefully to ensure that the Crown forest resources measured are representative of all the Crown forest resources harvested. The percentage measured may vary depending on the scaling method used.

The approved sample scaling percentages are as follows:

- 100% scale - all methods of measurement
- 20% scale - fixed length cube scale and tree length operations
- 10% scale - fixed length cube scale operations only

Note: The sample scaling percentage for containers (e.g. rail cars, trucks) is stated in the sampling plan and the scaling agreement.

2. SAMPLE SCALING OF CONIFER, POPLAR AND WHITE BIRCH

a) Measuring Procedure

Measured logs are scaled in accordance with this Manual and the data recorded by species and net diameters for fixed length and gross diameters for tree length. The scaler will measure the required number of pieces and mark the sawn surface of each measured piece with the letter **"S"** and each counted piece with a single stroke/paint mark. If approved by the **Ministry's Regional Measurement Coordinator**, the measured portion may be marked in an alternative manner (e.g. diameter class).

To reduce the possibility of bias, pieces must be measured, as encountered, in a section extending from the bottom to the top of the skidway.

The following two field methods may be applied when sample scaling:

1. Sample scaling may be applied to an individual skidway, in which case, all pieces in a skidway are counted and the required percentage of pieces is then measured.

Example 1: For a 10% sample in a skidway with 676 pieces, the scaler counts all the pieces, determines the pieces to be measured (676 x 10% = 67.6 rounded to 68) and then measures 68 pieces.

Example 2: For a 20% sample in a skidway with 467 pieces, the scaler counts all the pieces, determines the pieces to be measured (467 x 20% = 93.4 rounded to 93) and then measures 93 pieces.

2. Sample scaling may also be done by measuring/counting a predetermined number of pieces, either in an individual skidway, or in a group of skidways. The scaler then counts/measures the required number of pieces as per the sample scaling procedure. The last section of the skidway will be scaled by counting the remaining pieces and measuring the required percentage.

When using field method 2, the maximum number of pieces that may be counted and measured in one block in a skidway is **500 pieces**. The minimum block size will be set out in the Scaling Agreement.

Example 1: For a 10% sample in a skidway of 1000 pieces, the scaler counts 450 pieces and measures 50 pieces, then counts the next 450 pieces and measures another 50 pieces.

Example 2: For a 20 % sample in a skidway of 500 pieces, the scaler counts 400 pieces and measures 100 pieces.

For skidways of **fixed length timber, cull pieces** encountered within the measured section are tallied by species and piece only. They are clearly marked as culls and not included in the sheet (control) total. Cull pieces in the non-measured portion of the skidway are counted just like any other piece.

For example, in a skidway of **fixed length** timber, containing 750 total pieces that requires a 10% sample, the scaler must measure 75 pieces (10% of total pieces). In the measured section, 3 cull pieces are encountered. The scaler measures and records the net diameter for 72 merchantable pieces, and then records the 3 culls by species and piece. The sheet (control) total for this skidway is 720 not 750.

Example 3:

Measured number of pieces	= 72 x 10 = 720 (control total)
Cull pieces	= 3 x 10 = 30
Total number of pieces in skidway	= 75 x 10 = 750

b) Application of the sample factor

The volume of the measured portion is determined using either the cube method or the tree length method of measurement. This volume is multiplied by the sample factor to obtain the total net volume.

The sample factor is a two-digit number by which the percentage of sample is multiplied to equal 100.

Example 1: With a 10% fixed length sample, the sample factor is **10**.
25 measured pieces x 10 = 250 pieces.

Example 2: With a 20% tree length sample, the sample factor is **05**.
25 measured pieces x 05 = 125 pieces.

Example 3: With a 100% scale, the sample factor is **01**.
25 measured pieces x 01 = 25 pieces.

The net volume of the measured portion is multiplied by the sample factor to obtain the total net volume of the tally sheet.

IV – TRAINING AND LICENSING REQUIREMENTS

A. COURSES

Candidates for a scaler's licence must successfully complete a course of study approved by the Ministry of Natural Resources and pass examinations set by a Board of Examiners appointed by the Minister of Natural Resources. Courses are held under the direction of the Ministry of Natural Resources in various locations in the Province.

B. BOARD OF EXAMINERS

The Minister may appoint Boards of Examiners, composed of qualified and experienced persons, to examine and report upon the ability and knowledge of persons desiring to be licensed to measure Crown forest resources.

Every examiner, before assuming the duties of an examiner, shall take and pledge an oath in the following form:

I, ... do swear (or solemnly affirm) that I will act as examiner of scalers to the best of my ability and knowledge, and will conduct the examination without fear, favour or affection and recommend for licences only those persons who have satisfactorily proven their ability to perform the duties of measuring Crown forest resources. So help me God. (Omit this phrase in an affirmation.)

The oath shall be transmitted to the Minister.

C. EXAMINATION

The Minister shall determine the standard and method of examination.

The Board of Examiners shall sit at such places and on such days as determined by the Minister, and shall examine all candidates who present themselves. At the close of the examination, or soon thereafter, the Board shall transmit to the Minister the names of such candidates they believe to have satisfactorily proven their ability to perform the duties of measuring Crown forest resources and whom they recommend as having the requisite skill and knowledge to warrant their being licensed as scalers.

The Lieutenant Governor in Council may make regulations determining the amount of the examination fee to be paid by candidates (CFSA, Section 69 (28)).

D. SCALER'S LICENCE

The Minister may issue a scaler's licence to any person who has been recommended by a Board of Examiners and who has taken the prescribed oath.

Before a scaler's licence is issued, the applicant shall take and pledge an oath in the following form:

I, ... do swear (or solemnly affirm) that while acting as a licensed scaler, without fear, favour or affection, and to the best of my judgement and skill, I will measure correctly in accordance with the authorized Scaling Manual, all Crown forest resources that I am employed to measure, and make true return of the same to the Ministry of Natural Resources or its officer or agent. So help me God. (Omit this phrase in an affirmation.)

The oath shall be transmitted to the Minister.

Every scaler's licence is valid for **three years** with the expiry date occurring on the 31st of March of the third year. The licence may be renewed up to three years after its expiry date. **Failure to renew within three years of the licence expiry date will result in the termination of the licence.**

Example 1: A Scaler's Licence is issued on 1st of April, 2006. This Licence will expire on the 31st of March, 2009. The scaler has until the 31st of March, 2012 to renew this Licence. Failure to renew on or before this date will result in termination of the Licence. If the Scaler's Licence is terminated, the person will be required to successfully complete a new set of examinations set by a Board of Examiners at a subsequent Provincial Scaling Course.

It is the responsibility of the scaler to renew his/her licence.

E. APPROVAL OF SCALERS

All scalers who will be measuring Crown forest resources for Ministry purposes require annual written approval from the **Ministry's Regional Measurement Coordinator**. This includes:

- Ministry employed scalers
- scalers employed by a company with a Domestic Scaling Agreement
- scalers employed for training purposes and special assignments

Such approval may be granted to scalers who:

- possess a **valid Scaler's Licence**
- have obtained suitable, **on the job training** with licensed, experienced scalers by working in actual field conditions
- have successfully completed an approved Ministry **Provincial Scaling Course** or a standard Ministry **Scaling Refresher Course** at least once during the **preceding three year** period

Ministry refresher courses are held regularly in various parts of the Province. Scalers attending the courses are required to pass field and written tests.

F. CODE OF ETHICS FOR SCALERS

1. A scaler must maintain the essential skills and knowledge to warrant being licenced to measure Crown forest resources.

2. A scaler will measure all Crown forest resources according to the "Scaling Manual" for Ontario as authorized under the Crown Forest Sustainability Act (Section 68 (1).

3. A scaler will ensure that Crown forest resources are accurately assessed and reported for the collection of Crown charges.

4. A scaler must demonstrate a clear understanding of sampling requirements and data collection processes, as defined in the **"Sampling Standards Manual"**, to ensure the type of information collected is suitable for the intended purpose.

5. A scaler shall submit all scaling information in an accurate, complete, legible and timely manner.

6. A scaler will carry out his/her duties in a responsible and dignified manner to demonstrate his/her knowledge, skills and experience in wood measurement to his/her employers, clients and peers.

7. A scaler must keep his/her employer's and client's business affairs, practices and processes in the strictest confidence, disclosing them only on his/her employer's or client's consent, or as may be legally required.

8. A scaler shall supervise, instruct and counsel his/her assistants, taking responsibility for the standard and the quality of their work.

9. A scaler will ensure that all measuring and recording equipment is in proper working order.

G. EQUIPMENT

There are four official scaling sticks used for measuring Crown forest resources (see Figure 48).

The **scaling stick marked MC-1** is used for measuring timber in cubic metres. This stick is graduated in even two centimetre classes with the class boundary occurring on the odd centimetre. In addition this stick shows diameter reductions for defective logs in each diameter class for material up to and including 5.7 metres. It also shows volumes of 2.54 metre timber in stacked cubic metres for each diameter class.

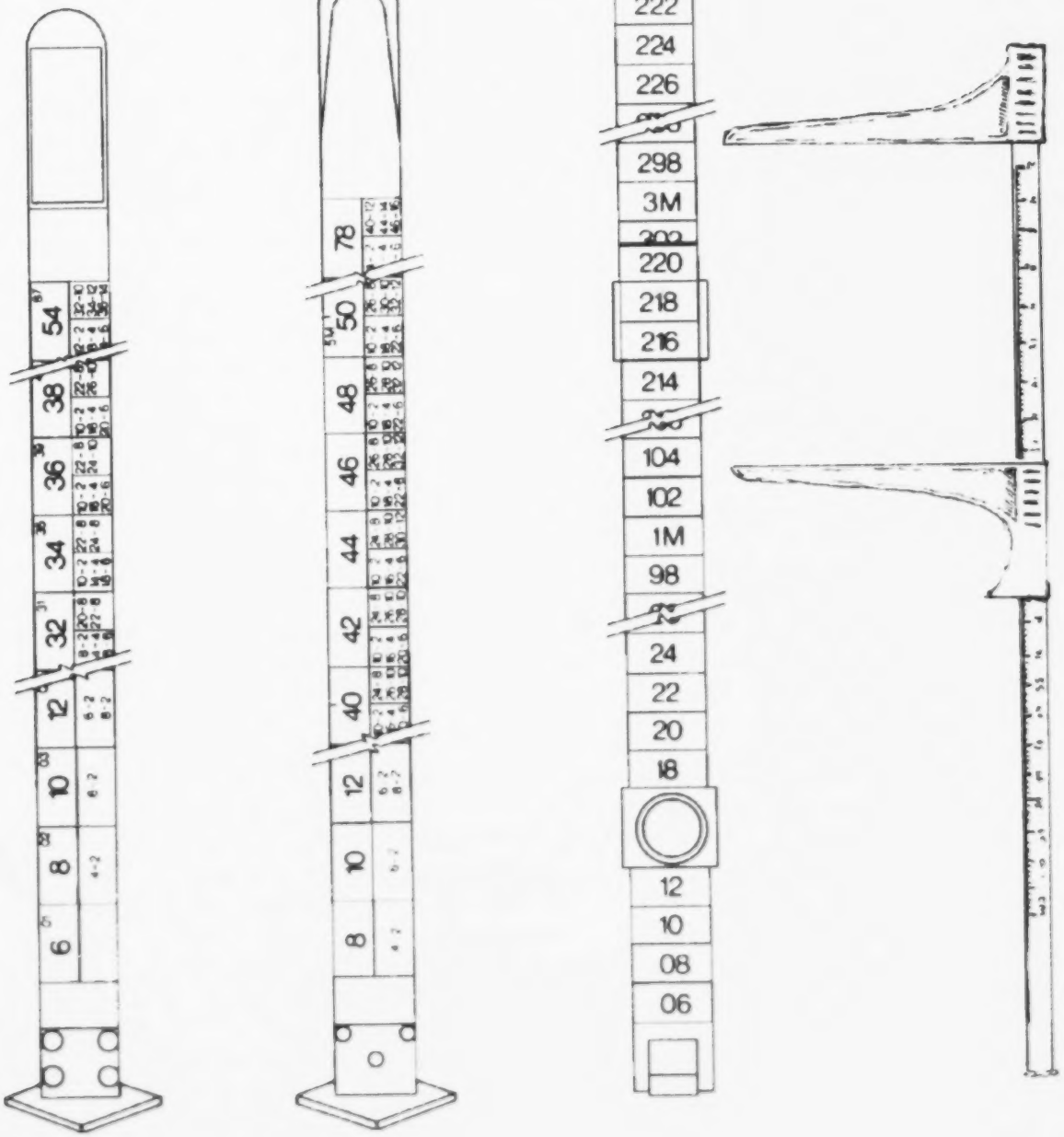
The **scaling stick marked MC-2** is used for measuring large diameter timber in cubic metres. It is graduated in even two centimetre classes with the class boundary occurring on the odd centimetre. It also shows diameter reductions for defective logs in each diameter class for material up to and including 5.7 metres.

The **scaling stick marked MS-1** is used for measuring wood in stacked cubic metres. This stick is graduated in even two centimetre classes with the class boundary occurring on the odd centimetre. It is 1.5 metres long and extends to a length of 3 metres.

The **scaling stick marked MS-2** is used for measuring wood in stacked cubic metres. This stick is graduated in even two centimetre classes with the class boundary occurring on the odd centimetre. It is 2 metres long and extends to a length of 4 metres.

Calipers are used as required for sampling tree lengths, measuring standing trees and sunken logs. They are graduated in even two centimetre classes with the class boundary occurring on the odd centimetre.

The use of other equipment requires the prior approval of the **Ministry's Provincial Measurement Supervisor.**



MC-1 MC-2 MS-1 (3M) MS-2 (4M) CALIPERS

Figure 48 - Scaling sticks and calipers

V – GENERAL

A. CHECK SCALING

Check scales assess the measurements of previously scaled stacks or skidways of Crown forest resources. Check scaling is conducted by licensed, experienced Ministry scalers approved by the **Ministry's Regional Measurement Coordinator**.

Check scaling:

- ensures that the determination of volume and stumpage values is accurate
- maintains uniform scaling practices throughout the Province
- ensures compliance with the Scaling Manual
- provides opportunities for continuing instruction to scalers on actual operations

Check scales should be **conducted at least once a month** for each active Ministry or domestic scaler. Check scaling must **take place at the location where the timber was originally measured, using the same scaling method, with the timber in the same form in which it was originally scaled.**

The allowable margin of error is **±5%** of the official check scale.

Note: Refer to Section V (K) for allowable margin of error on Sampling for Factors.

The Ministry assumes the responsibility for the cost of check scaling. If a check scale indicates the scaler is outside the allowable margin of error, then the Ministry may request that the Crown forest resources measured by the scaler be remeasured at the expense of the licensee. Furthermore, if such a check scale shows excessive discrepancies in relation to either species, diameters, lengths, heights, quality or method of measurement, the Ministry may require that the scaler be removed from scaling duties pending a satisfactory resolution of the situation.

When **cubed wood** is check scaled, net diameters, lengths and cull logs will be recorded by species.

When **tree length** timber is check scaled, only gross diameters by species will be recorded.

When **stacked wood** is check scaled, the measurements (height, length and width of stack), and volumes of undersize, defect, voids, and minor species of each stack will be recorded.

When timber measured by **log grade** is check scaled, gross diameters, lengths, grades and cull logs by species will be recorded.

Check scale reports must be reviewed, approved and retained by the **Ministry's Regional Measurement Coordinator**.

B. DISPUTE SETTLEMENT

To settle a dispute between the Ministry and a company involving the measurement of Crown forest resources, a rescale may be required. The measurement of the disputed Crown forest resources must:

- be conducted by Ministry scalers
- take place at the location where the wood was originally measured
- be measured using the same scaling method as the original scale
- be in the form in which it was originally scaled

Adjustments to volumes, if necessary, will be made on the disputed Crown forest resources.

If either the Ministry or the company requests a rescale, the cost of such rescale will be borne by the party requesting the rescale if the original scale is shown to be correct.

The Ministry shall be the sole arbiter in disputes concerning Crown forest resources.

The Ministry will not enter into, nor arbitrate scaling disputes:

- between a company and a union
- between companies
- between companies and contractors, or
- in any other situation where scaling is not done for Ministry purposes

C. COMPANY SCALERS MEASURING FOR MINISTRY PURPOSES

The Minister may authorize the measurement of Crown forest resources, for Ministry purposes, by approved scalers employed by companies. They shall scale and make returns in accordance with the Scaling Manual.

All Crown forest resources measured by company scalers are subject to Ministry check scales and audits. At the request of an authorized Ministry official, all scaling records (e.g. tally sheets, check scales, summaries, invoices, statements of accounts, etc.) of Crown forest resources measured are to be made available for inspection or audit at reasonable times (CFSA, Section 62).

Copies of all Ministry check scales will be made available to the company concerned.

Company scalers, measuring for Ministry purposes, must measure and record **all merchantable material** of any species **used for fuelwood, skids, camps, bridges, corduroy** or any construction work on forest operations.

Company scalers may **assist**, with the written approval of the **Ministry's Regional Measurement Coordinator**, in sampling Crown forest resources to:

- establish mass/volume ratios
- determine undersize factors
- determine product distribution factors
- determine average volumes of Crown forest resources in containers
- construct tree length volume tables
- determine defect factors
- determine species distribution factors
- determine grade distribution factors
- gather statistical information for Ministry purposes

Measuring and recording for the above purposes must be done in accordance with the instructions in the Scaling Manual and the Sampling Standards Manual.

D. INFRACTIONS

INVOLVING CROWN FOREST RESOURCES

The Forest Operations and the Silviculture Manual prohibits wasteful practices, hauling unscaled Crown forest resources and unauthorized harvesting (trespass). The Forest Operations and Silviculture Manual references the Scaling Manual for methods of measurement, definitions of wasteful practices and unauthorized hauling.

All measurements of Crown forest resources relating to unauthorized harvesting, wasteful practices and unauthorized hauling of Crown forest resources must be conducted **by licenced and approved Ministry scalers** or in a manner approved by the **Ministry's Regional Measurement Coordinator**.

E. WASTEFUL PRACTICES

Minimum utilization standards have been designed to promote good forest management by ensuring optimum utilization of Crown forest resources on harvesting operations.

The minimum utilization standards must be followed on all forest operations unless otherwise described in an approved Forest Management Plan. For example, merchantable trees and/or wood fibre may be left at a harvest site in order to satisfy silviculture and habitat requirements or because of market related issues associated with a certain species or product.

Leaving merchantable trees at the harvest site because of market related issues must not jeopardize the silviculture or habitat objectives of that harvest site. Reasons for leaving merchantable trees and/or wood fibre in specific areas within a forest must be described in the approved Forest Management Plan.

Failure to comply with minimum utilization standards unless otherwise described in the Forest Management Plan is a wasteful practice. No person shall commit wasteful practices in forest operations.

Policy and Procedure ENF 14.15.01 and ENF 14.15.02 or their successors titled "Wasteful Practices" shall be used when evaluating wasteful practices for reporting purposes in the Forest Operations Inspection Program.

Procedure FOR 05 05 42 titled "Penalty Scaling" provides direction for the measurement process.

When assessing wasteful practices, all infractions encountered will be tallied.

This Manual defines five kinds of wasteful practices.

1. LEAVING HIGH STUMPS

It is a wasteful practice to leave high stumps.

Stump height is the vertical distance between the horizontal plane through the highest point of the stump and the horizontal plane through the highest point of the ground (includes boulders) at its base (see Figure 49).

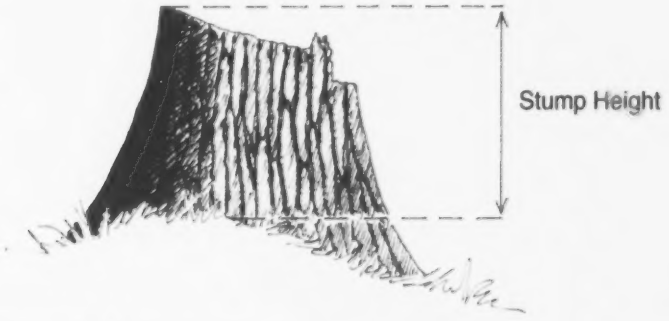


Figure 49 - Stump height

A tree must not be felled so that its stump height is greater than 30 centimetres (see Figure 50), except that a tree may be felled so that its stump height is not greater than its diameter measured outside the bark at the point of cutting (see Figure 51). Regardless of diameter, no tree may be felled so that its stump height is greater than 60 centimetres (see Figure 52).

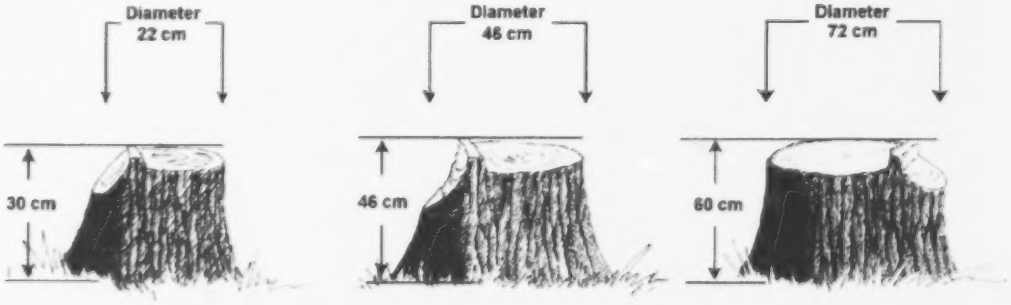


Figure - 50 Figure - 51 Figure - 52

Measuring Tree Stumps

2. LEAVING MERCHANTABLE TIMBER OF ANY LENGTH

It is a wasteful practice to leave merchantable timber of any length in any part of an approval area at the time when a licensee:

- ceases operations in that part (e.g. on the expiry of the annual "Approval to Commence Harvesting Operations" or without a written request from the company to extend operations to the next operable season, that has been approved by the Ministry)
- abandons their licence
- fails to renew their licence
- has not scaled the timber for Crown charges, or
- has scaled the timber for Crown charges

Merchantable timber means:

(a) Any conifer, poplar or white birch log in which more than one half the total content, measured in cubic metres, is sound wood and:

i) in the case of a felled conifer other than white pine, red pine or hemlock having a diameter of 10 centimetres (diameter class) or more **outside the bark** (DOB), at the smaller end (see Figure 53).

Figure 53 - Example of merchantable jack pine timber

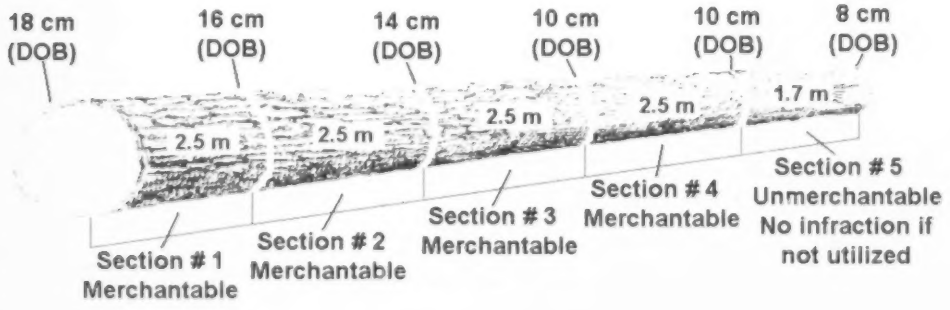


Figure 54 - Example of jack pine timber with unmerchantable section

ii) in the case of felled white pine, red pine, hemlock, poplar or white birch having a diameter of 14 centimetres (diameter class) or more **outside the bark** (DOB), at the smaller end (see Figure 55).

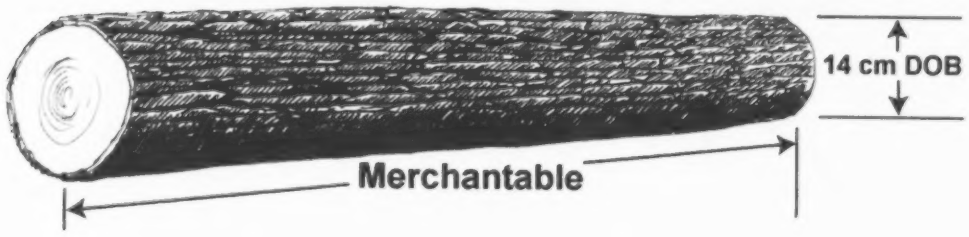


Figure 55 - Example of merchantable white pine timber

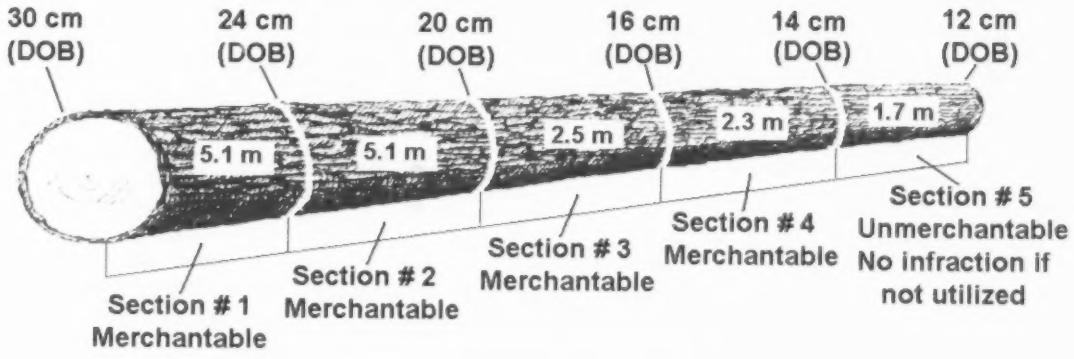


Figure 56 - Example of white pine timber with unmerchantable section

(b) Any hardwood log other than poplar or white birch in which more than one third of the total content measured in cubic metres is sound wood and:

i) measuring 18 centimetres (diameter class) or more in diameter **outside the bark** (DOB), at the smaller end (see Figure 57).

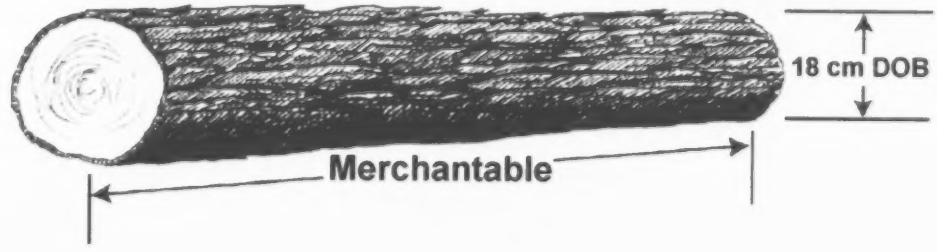


Figure 57 - Example of merchantable maple timber

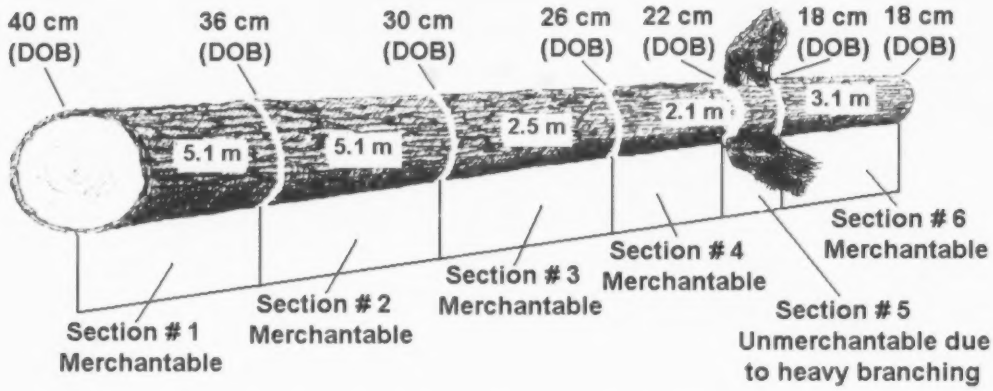


Figure 58 - Example of maple timber with unmerchantable section

Where in the opinion of the Minister, sufficient markets exist for material smaller than that described in (a) (ii) and (b) (i) above, and only if agreed upon by the licensee in the approved **Annual Work Schedule**, the diameter outside the bark at the smaller end for merchantable timber may be reduced.

Heavy branching means the lowest part of a tree where the growth of branches is so concentrated that the timber in that section is considered unmerchantable.

The term **"merchantable timber of any length"** does not apply to **all hardwoods** (including poplar and white birch), **white pine**, **red pine** and **hemlock** beyond the point of heavy branching where a piece less than 2.5 metres remains (see Figure 59).

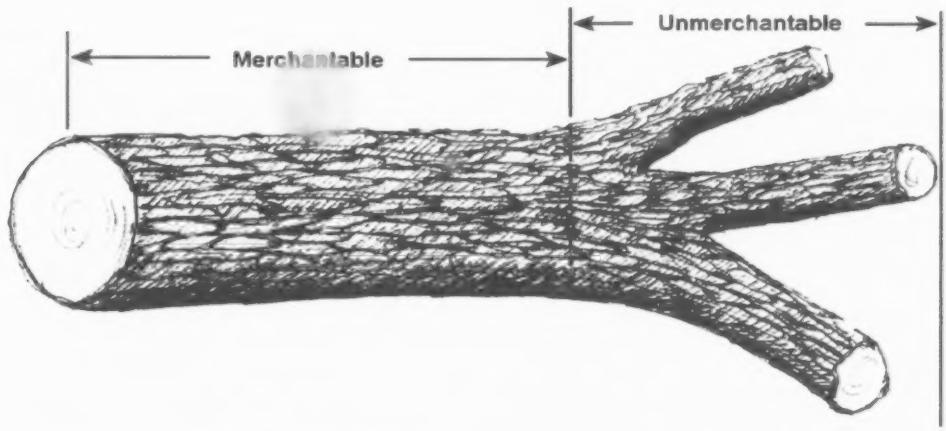


Figure 59 - Example of unmerchantable sections that are less than 2.5 metres in length in an area of heavy branching

The term **"merchantable timber of any length"** does not apply where a piece less than 2.5 metres in length remains after an **unmerchantable section** is encountered on **the top end of the stem only** (see Figure 60).

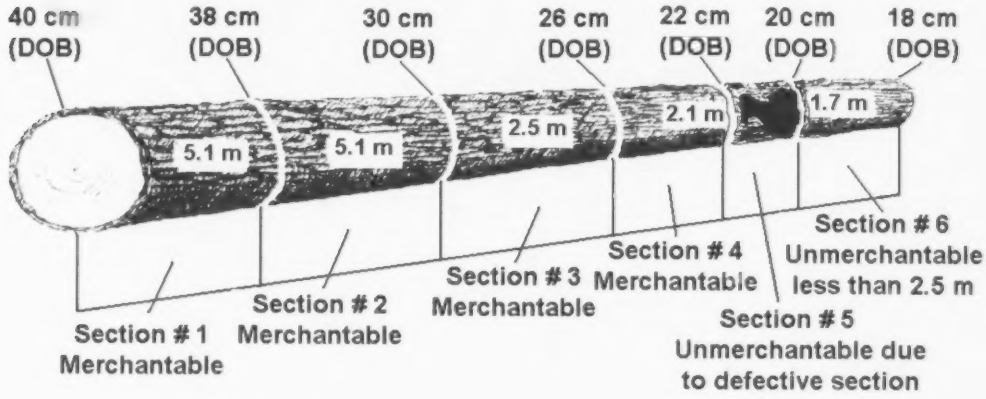


Figure 60 - Example of timber with unmerchantable section

3. LEAVING MERCHANTABLE TREES

It is a wasteful practice to leave any merchantable trees standing that the licensee has the right to harvest on any part of an approval area, at the time when the licensee:

- ceases operations in that part (e.g. on the expiry of the annual "Approval to Commence Harvesting Operations" or without a written request from the company to extend operations to the next operable season, that has been approved by the Ministry)
- abandons their licence, or
- fails to renew their licence

Merchantable Tree Means:

- a standing conifer, poplar or white birch tree where more than one half the total wood content is sound; or

- a standing hardwood tree, other than poplar or white birch, where more than one third of the total wood content is sound.

4. LEAVING LODGED TREES

It is a wasteful practice to leave lodged trees in an area where harvesting operations have been conducted.

"Lodged" refers to a tree, that for other than natural causes, does not fall to the ground after being:

- partially or wholly separated from its stump, or
- displaced from its natural position (see Figures 61, 62, and 63).

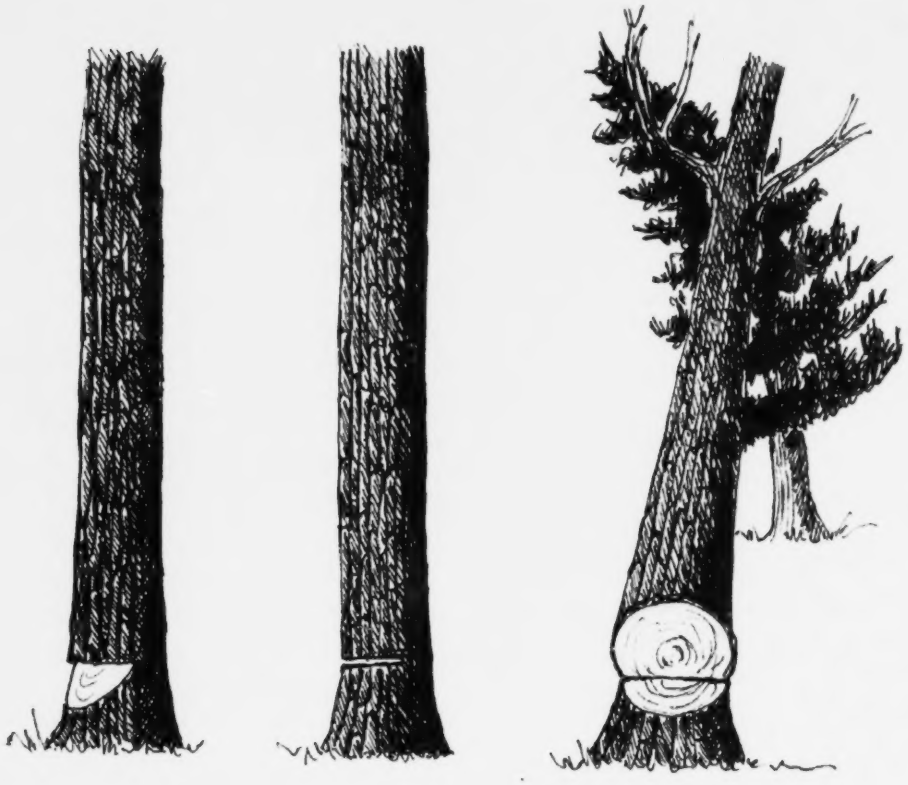


Figure 61 - Examples of lodged trees that are partially or wholly separated

Figure 62 - Example of a lodged tree displaced from its natural position

Figure 63 - Example of a lodged tree displaced from its natural position

5. NOT UTILIZING WOOD CHIP FIBRE

It is a wasteful practice not to utilize wood chip fibre.

Wood chip fibre is chip fibre of any species produced by a chip manufacturing facility, whether fixed or mobile.

Figure 64 - Examples of not utilizing wood chip fibre.

F. ASSESSMENT OF PENALTIES

Administrative penalties for wasteful practices, as defined by the minimum utilization standards described in Part E of this Manual, are set out in the Crown Forest Sustainability Act, Section 58(1)(e).

An administrative penalty for wasteful practices may be assessed even if the timber:

- has been measured, stumpage values collected and a reasonable market opportunity exists, or
- has been measured and stumpage values have not been collected, or
- has not been measured

G. UNAUTHORIZED HARVESTING

Unauthorized harvesting or possession of Crown forest resources occurs in any of the following situations:

- a person harvests resources in a Crown forest without the authority of a Forest Resource Licence (CFSA Section 58(1)(a))
- a person fails to comply with the Forest Resource Licence (CFSA Section 58(1)(b))
- a forest resource licensee harvests Crown forest resources without the written annual approval of the Minister (CFSA Section 58(1)(e))
- a forest resource licensee harvests Crown forest resources outside the approval area (CFSA Section 58(1)(d) or 58(1)(e))

H. UNAUTHORIZED HAULING OF CROWN FOREST RESOURCES

Unauthorized hauling is the movement of Crown forest resources from the place of harvesting **before measurement**, without the written approval of the Minister (CFSA Section 45(1) and 45(3)).

Violation of, or non-compliance with, any of the conditions specified in the "Authority to Haul Unscaled Crown Forest Resources" is also considered to be an unauthorized haul. Minimum requirements for the movement of Crown forest resources before measurement are described in Section I (2) of this Manual.

The maximum monetary penalty for unauthorized hauling of Crown forest resources is set out in the Crown Forest Sustainability Act, Section 58(1)(e).

I. MOVEMENT AND MEASUREMENT OF CROWN FOREST RESOURCES

1. SCALING AGREEMENTS

Scaling Agreements are legal documents authorizing the measurement of Crown forest resources (CFSA Section 45(1) and 45(3)). Scaling Agreements are used by the Ministry to establish partnerships with industry for the measurement and reporting of scaling data.

Scaling Agreements address elements such as:

- parties to the agreement
- parties responsible for measurement
- location of measurement
- method of measurement
- method and schedule of reporting measurement data
- management of records
- other elements as required

TYPES OF AGREEMENTS

- A **domestic scaling agreement** permits the scaling of Crown forest resources, by approved company scalers at the harvest site, for Ministry purposes.

- A **central scaling agreement** permits the scaling of Crown forest resources, in a mill yard or designated concentration point by approved company or Ministry scalers, for Ministry purposes.

- A **mass scaling agreement** permits the weighing of Crown forest resources, on approved weigh scales, for Ministry purposes.

- A **container scaling agreement** permits the application of average volumes of Crown forest resources by container (e.g. railcar, truck) for Ministry purposes. Container volumes are determined by sampling.

- A **gang scaling agreement** permits the scaling of Crown forest resources, by Ministry scalers, for both internal company use and Ministry purposes.

All scaling agreements must be authorized by the Minister through the **Ministry's Regional Measurement Coordinator.**

2. MOVEMENT OF UNSCALED CROWN FOREST RESOURCES

Unscaled Crown forest resources must not be moved from the place of harvest (CFSA, Section 45(1)) without authorization of the Minister.

An "Authority to Haul Unscaled Crown Forest Resources" may be granted (CFSA, Section 45 (3)) to permit the hauling of unscaled Crown forest resources from the place of harvest to approved measuring locations. Authorization is granted by the Minister through the **Ministry's Regional Measurement Coordinator** and will be issued to the licensee annually.

The Authority to Haul Unscaled Crown Forest Resources contains conditions related to the movement and measurement of the Crown forest resources harvested by the licensee.

3. BILLS OF LADING

Bills of lading are required by the **Authority to Haul Unscaled Crown Forest Resources** as a means to control the movement of Crown forest resources and facilitate auditing.

All bills of lading must:

- be approved by the **Ministry's Regional Measurement Coordinator**
- be pre-numbered consecutively
- contain the following minimum information:
  - Date
  - Licensee
  - Vehicle identification
  - Species
  - Measuring location
  - Approval number
  - Destination (name or code)
  - Signature of issuer/trucker
  - Any other information requested by the **Ministry's Regional Measurement Coordinator**
- be accurately completed
- at a minimum, be reconciled at the completion of hauling operations

If there is already sufficient control in the opinion of the **Ministry's Regional Measurement Coordinator**, a bill of lading may not be required.

4. MOVEMENT OF CROWN FOREST RESOURCES OUTSIDE CANADA

Crown forest resources must be manufactured into products in Canada unless an exemption is provided by the Minister (CFSA Section 30(3)). The written exemption from the Minister will specify the conditions under which the movement and measurement of Crown forest resources will occur.

J. SCALING AUDIT

The purpose of a scaling audit is to provide assurance that the Crown's interests, financial and other, are adequately protected with respect to the movement, measurement, recording and reporting of Crown forest resources. Section 62 of the CFSA provides the authority to conduct audits.

The audit program is administered by the Ministry's Regional Measurement Coordinator and/or the Provincial Measurement Supervisor.

The latest edition of the **Scaling Audit Reference Manual** is the standard to which all scaling audits must conform. The standards and processes contained in that Manual have been adapted from:

- Generally Accepted Auditing Standards (GAAS), as set out in the Canadian Institute of Chartered Accountant's Handbook
- standards for the Professional Practice of Internal Auditing as developed by the Institute of Internal Auditors
- direction from scaling audit workshops

All scale records, regardless of whether they are compiled for the Ministry or the company, are to be made readily available to Ministry officials in company offices at reasonable times.

1. TRAINING REQUIREMENTS

Candidates for an Audit Certificate must successfully complete a course of study approved by the Ministry of Natural Resources and pass examinations set by a Board of Examiners appointed by the Minister of Natural Resources.

2. BOARD OF EXAMINERS

The Minister may appoint boards of examiners composed of qualified and experienced persons to examine and report upon the ability and knowledge of persons desiring to be certified to conduct scaling audits.

3. EXAMINER'S OATH

Every examiner, before entering upon the duties of an examiner, must take the following oath:

I, ... do swear (or solemnly affirm) that I will act as an examiner of candidates desiring to obtain a Scaling Audit Certificate, to the best of my ability and knowledge, will conduct the examination without fear, favour or affection and will recommend for Certificates only those persons who have satisfactorily demonstrated their ability to carry out audit practices and procedures as set out in the Scaling Audit Reference Manual. So help me God. (Omit this phrase in an affirmation.)

The oath shall be transmitted to the Minister.

4. EXAMINATION

The Minister shall determine the standard and method of examination.

The Board of Examiners shall sit at such places and on such days as determined by the Minister, and shall examine all candidates who present themselves. At the close of the examination, or soon thereafter, the Board shall transmit to the Minister the names of such candidates they believe to have satisfactorily proven their ability to discharge the duties of conducting scaling audits and whom they recommend as having the requisite skill and knowledge to warrant receiving a Scaling Audit Certificate.

5. AUDITOR'S OATH

Before a Scaling Auditing Certificate is issued, the candidate must take the following oath:

I, ... do swear (or solemnly affirm) that when auditing records pertaining to the movement and measurement of Crown forest resources, I will faithfully discharge my duties as an Auditor and will act in a professional manner and conduct audits in accordance with the authorized Scaling Audit Reference Manual, except as I may be legally required I will not disclose or give to any person any information or document that comes to my knowledge or possession by reason of conducting the audit. So help me God. (Omit this phrase in an affirmation).

The oath shall be transmitted to the Minister.

K. SAMPLING FOR FACTORS

When the calculation of volumes and determination of stumpage values requires the application of scaling factors, it is critical to both the forest industry and the Ministry that accurate factors be developed and maintained. To ensure the accuracy of data collected during sampling, only licensed, approved, experienced scalers must be assigned to this work. They should be regularly check scaled. The allowable margin of error is **±3%** of the official check scale.

All sampling for these factors requires a well designed sampling plan approved by the **Ministry's Regional Measurement Coordinator**.

The latest edition of the **Sampling Standards Manual** is the standard to which all sample plans and sampling procedures must conform. The eight types of sampling carried out in the Province are:

1. **Mass/Volume:** This factor is required when Crown forest resources are mass measured to convert weight to solid cubic metres.

2. **Tree Length Volume Tables:** These tables are required where the timber is butt scaled in tree length form. Tables are produced that provide the volume to be applied for each tree length butt diameter class.

3. **Defect:** Determination of a defect factor is required where Crown forest resources are mass or tree length scaled. Defect factors may be applied to stack measure if approved by the **Ministry's Regional Measurement Coordinator**.

4. **Species Distribution:** Species distribution factors are required where Crown forest resources are mass measured and mixed species are hauled together. Species distribution factors may be applied to stack measure if approved by the **Ministry's Regional Measurement Coordinator**.

5. **Grade/Category Distribution:** Grade distribution factors for tolerant hardwoods and category distribution factors for white and red pine are required when:

   - graded hardwoods (except poplar and white birch) are mass measured or cube scaled

   Grade distribution may be reviewed annually with the licensee when timber is mass measured or when a grade distribution factor is applied to piece scaled material. Grade factors must be based on previously implemented or collected data. Negotiated factors are subject to the approval of the **Ministry's Regional Measurement Coordinator**.

   - white pine and red pine are mass measured or tree length scaled

6. **Product Distribution:** Product distribution factors are required when Crown forest resources are sorted by product sector after measurement. This could occur when tree length is slashed into separate products (e.g. veneer, sawlogs and pulpwood).

7. **Container:** Sampling of containers (e.g. truck or railcar) is required where volumes are determined and billed by the container. These volumes may be included in the scaling agreement.

8. **Undersize:** Sampling for an undersize deduction is required where mass measuring is used to determine volumes. Undersize factors may also be applied to other methods of measurement if approved by the **Ministry's Regional Measurement Coordinator**.

Sample plans must be prepared and approved for collection of data to determine scaling factors. All sampling must be conducted under the direction of a sample plan.

Sampling for different types of factors may be done in conjunction with each other.

The reliability of the sampling data depends on the following **three** factors:

- **A well-designed sampling plan** that distributes the sampling uniformly over the operating season and harvesting area, to ensure that variations in size and form of trees are represented in the sample. The sampling plan must be approved by the **Ministry's Regional Measurement Coordinator**.
- **The care** with which the sample trees are measured.
- **The size of the sample,** that is, the number of trees that must be sampled.

L. INFORMATION COLLECTION AND MANAGEMENT

1. DESTINATION CODES

A destination code is a numeric code assigned to each forest resource processing facility. This code is recorded on all scaling returns as it **identifies the product sector on the stumpage matrix for determining the applicable Crown charges.**

2. DATA COLLECTORS

Data collectors are portable computerized units used for recording data. They must meet standards that allow for collecting and transferring data to the Ministry's data management system. Data from the units must be downloaded and backed-up regularly. A hard copy of all data must be available upon request by the Ministry.

Use of data collectors must be approved by the **Ministry's Regional Measurement Coordinator**.

3. TALLY SHEETS, FORMS AND RECORDS

All Crown forest resources measured must be recorded on forms approved by the **Ministry's Regional Measurement Coordinator**.

All scale returns must be sent to the Ministry in a timely manner. The company and the Ministry will agree on a transfer schedule. Where companies fail to forward scale returns on schedule, the Ministry may apply interest penalties on the volumes of Crown forest resources not processed.

4. ELECTRONIC DATA TRANSFER

Electronic data transfer is an economical method of transferring scaling returns directly from the company source to the Ministry's data management system. Scaling data passing through a company electronic transfer system must not be altered prior to transmission to the Crown. Any such data transfer system must be designed with safeguards for protecting the Crown's interests.

The current methods of electronic data transfer make use of:

- dial-up on-line transfer
- internet

The **Provincial Measurement Supervisor** sets the standards and approves the transfer procedure.

The Scaling Agreement will define the schedule for the transfer of scale data (electronic or hard copy) to the Ministry from the company. Where companies fail to transmit scale returns on schedule, the Ministry may apply interest penalties on the volumes of Crown forest resources not processed.

VI - APPENDICES

APPENDIX A

LOG IDENTIFICATION

DEFINITIONS

Bark	The outer portion is dry, hard, and forms many patterns. The inner portion is soft, and usually lighter in colour.
Wood	Consists of heartwood and sapwood. The sapwood surrounds the heartwood and is usually lighter in colour.
Rays	Show on the end of some logs as fine lines like the spokes of a wheel.
Annual Ring	The end of a log shows concentric rings. Each ring represents the annual growth of spring and summer wood. The spring wood is the inner portion of the annual ring. The summer wood is the outer portion and is a darker colour.
Ring Porous	Open grained woods. Some hardwoods have large openings or pores in the spring wood, easily detected by the eye.
Diffuse Porous	Close grained woods. The pores in other hardwoods are too small to be seen easily.

HARDWOODS

A. **Diffuse porous; rays visible: maple, black cherry, beech.**

1. Maple
   Greyish bark in flaky ridges that turn out at sides or ends.
   Heartwood - reddish brown usually irregular in outline.
   Rays - fine, thread-like lines.

2. Soft Maple
   Bark is greyish-brown, scaly, turning up at the ends. Inner bark is reddish/orange.
   Heartwood - usually large and brown.
   Rays - fine and hard to determine.

3. Black Cherry
   Dark bark, numerous, fine, brittle scales turned out at edges.
   Heartwood - dark reddish brown.
   Sapwood - narrow, white to light reddish brown.
   Rays - easily determined.

4. Beech — Thin, smooth, light greyish bark.
Heartwood - light reddish brown.
Rays - easily determined, appear broken and irregular. On the wood under the bark there are irregular dash-like marks.

B. Diffuse porous wood; rays not visible: Birch, Basswood, Poplar.

1. Birch — Heartwood - usually regular in outline, light to reddish brown showing milky circles.
Yellow birch - yellowish bark in thin layers of curly or flat flakes.
White birch - creamy white bark in thin paper-like layers.

2. Basswood — Wood is very soft. Outer bark has flat-topped ridges on large logs, is smooth on small logs. Inner bark is fibrous and usually separated from the wood. The line between wood and bark is scalloped.
Heartwood - not easily recognized, may be slightly stained, often diseased.

3. Poplar — Wood is hard when dry. Outer bark is smooth or broken up into hard, flat topped ridges, separated by shallow fissures. Interior bark does not separate from wood.
Heartwood - is hard to determine and may be slightly stained and often diseased.

C. Ring porous wood; rays not visible: Black Ash, White Ash, and White Elm.

1. Black Ash — Soft **thin** layer of grey, scaly or slightly ridged outer bark, with a **thick** layer of inner bark.
Heartwood - brownish.
Sapwood - narrow layer of greyish white.
Annual ring - a wide layer of open-grained wood, and a narrow layer of close grained wood.
Wood - dull in appearance.

2. White Ash — A **thick** layer of outer bark with dark grey, short, firm, rounded ridges separated by deep fissures, with a thin layer of inner bark.
Heartwood - brownish appearance.
Sapwood - wide layer, whitish colour.
Annual ring - a narrow layer of open-grained wood and a wide layer of fine grained wood.
Wood - somewhat lustrous.

3. White Elm — Outer bark has firm rounded ridges, the cross section of which shows dark brown and light layers.
Heartwood - easily determined with a thick layer of sapwood.
Annual ring - narrow layer of open-grained wood consisting of one line of large openings.
The close grained wood shows white wavy lines.

D. Ring porous. Rays prominent.

1. Red Oak — Outer bark is smooth or broken up into hard, flat-topped ridges, separated by shallow fissures.
Heartwood - easily determined.
Rays - are conspicuous and vary in width.
Annual ring - open-grained wood and is conspicuous.

Conifers Softwoods - Appendix A - Log Identification

A. **Gum in wood - Heartwood easily determined.**

1. White Pine — Gum in sapwood only, appearing in three stages: large, bead like bubbles, then liquid and stringy, finally drying up leaving a white-washed appearance.
Bark - large logs, ridged, dark; small logs, smooth, greenish.

2. Red Pine — Small beads of gum in heartwood and sapwood.
Reddish bark, in loose flakes, rosy-purple under the scales.
Heartwood - orange to buff in colour, irregular in outline.

3. Jack Pine — Small beads of gum in heartwood and sapwood.
Brown, scaly bark, brownish under the scales.
Heartwood - brownish colour.
Knots - trough-like depression above and below knot.

4. Larch (Tamarack) — Small beads of gum in heart and sapwood.
Reddish brown bark, purple under the scales.
Annual rings - very distinct.
Heartwood - dark colour, distinct contrast between sapwood and heartwood.

B. Gum in wood - Heartwood hard to determine.

1. Spruce — Small beads of gum in sapwood **only.**
Gum dries up leaving a rough sandpaper-like surface.
White spruce, silvery pink under scales.
Black spruce, olive green under the scales.

C. Gum in bark.

1. Balsam — Liquid-like gum contained in blisters in young, smooth bark.
In the older, ridged bark, gum is crystallized.
Heartwood - hard to determine.

2. Cedar — Amber-coloured beads of gum appear in inner bark. Outer bark is broken up into narrow, fibrous ridges.
Heartwood - easily determined, often defective.

D. No gum in bark or wood.

1. Hemlock — Outer bark brownish with purple streaks.
Heartwood - hard to determine.
Wood is light brownish colour. "Shake" often present.

APPENDIX B

TREE SPECIES CODES AND SYMBOLS THAT APPLY TO SCALING

Code	Tree Species	Symbol	Code	Tree Species	Symbol
01	White pine	Pw	43	Oak, all	O
02	Red pine	Pr	44	Beech	Be
03	Jack pine	Pj	48	Ash, all	A
04	Scots pine	Ps	49	Elm	Em
11	Pine, all	P	51	Basswood	Bd
12	White spruce	Sw	53	Hickory	Hi
13	Black spruce	Sb	54	Black walnut	Wn
18	Spruce, all	S	55	Butternut	Bn
19	Hemlock	He	56	Ironwood	I
20	Balsam fir	B	58	Black cherry	Ch
24	Cedar	Ce	75	Poplar, all	Po
25	Larch (Tamarack)	La	90	White & Red pine	
29	Conifers, all	C	91	Grade 1 & Grade 2 hardwoods	
35	Soft maple	Ms	92	Grade 2 hardwoods	
36	Maple, all	M	98	Species all (Sort 1)	
37	Yellow birch	By	99	Hardwoods, all	
38	White birch	Bw	00	Species all (Sort 2)	
39	Poplar & White birch				

APPENDIX C

SQUARES OF NUMBERS

VOLUME AND DEDUCTION TABLES

TABLE 1

SQUARES OF NUMBERS

$4^2 = 16$	$32^2 = 1024$	$62^2 = 3844$
$6^2 = 36$	$34^2 = 1156$	$64^2 = 4096$
$8^2 = 64$	$36^2 = 1296$	$66^2 = 4356$
$10^2 = 100$	$38^2 = 1444$	$68^2 = 4624$
$12^2 = 144$	$40^2 = 1600$	$70^2 = 4900$
$14^2 = 196$	$42^2 = 1764$	$72^2 = 5184$
$16^2 = 256$	$44^2 = 1936$	$74^2 = 5476$
$18^2 = 324$	$46^2 = 2116$	$76^2 = 5776$
$20^2 = 400$	$48^2 = 2304$	$78^2 = 6084$
$22^2 = 484$	$50^2 = 2500$	$80^2 = 6400$
$24^2 = 576$	$52^2 = 2704$	$82^2 = 6724$
$26^2 = 676$	$54^2 = 2916$	$84^2 = 7056$
$28^2 = 784$	$56^2 = 3136$	$86^2 = 7396$
$30^2 = 900$	$58^2 = 3364$	$88^2 = 7744$
	$60^2 = 3600$	$90^2 = 8100$

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM. (CM)	LENGTHS IN METRES								
	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7
10	0.009	0.010	0.012	0.013	0.015	0.016	0.018	0.020	0.021
12	0.012	0.015	0.017	0.019	0.021	0.024	0.026	0.028	0.031
14	0.017	0.020	0.023	0.026	0.029	0.032	0.035	0.038	0.042
16	0.022	0.026	0.030	0.034	0.038	0.042	0.046	0.050	0.054
18	0.028	0.033	0.038	0.043	0.048	0.053	0.059	0.064	0.069
20	0.035	0.041	0.047	0.053	0.060	0.066	0.072	0.079	0.085
22	0.042	0.049	0.057	0.065	0.072	0.080	0.087	0.095	0.103
24	0.050	0.059	0.068	0.077	0.086	0.095	0.104	0.113	0.122
26	0.058	0.069	0.080	0.090	0.101	0.111	0.122	0.133	0.143
28	0.068	0.080	0.092	0.105	0.117	0.129	0.142	0.154	0.166
30	0.078	0.092	0.106	0.120	0.134	0.148	0.163	0.177	0.191
32	0.088	0.105	0.121	0.137	0.153	0.169	0.185	0.201	0.217
34	0.100	0.118	0.136	0.154	0.173	0.191	0.209	0.227	0.245
36	0.112	0.132	0.153	0.173	0.193	0.214	0.234	0.254	0.275
38	0.125	0.147	0.170	0.193	0.215	0.238	0.261	0.284	0.306
40	0.138	0.163	0.188	0.214	0.239	0.264	0.289	0.314	0.339
42	0.152	0.180	0.208	0.236	0.263	0.291	0.319	0.346	0.374
44	0.167	0.198	0.228	0.258	0.289	0.319	0.350	0.380	0.411
46	0.183	0.216	0.249	0.283	0.316	0.349	0.382	0.415	0.449
48	0.199	0.235	0.271	0.308	0.344	0.380	0.416	0.452	0.489

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7
50	0.216	0.255	0.295	0.334	0.373	0.412	0.452	0.491	0.530
52	0.234	0.276	0.319	0.361	0.404	0.446	0.488	0.531	0.573
54	0.252	0.298	0.344	0.389	0.435	0.481	0.527	0.573	0.618
56	0.271	0.320	0.369	0.419	0.468	0.517	0.566	0.616	0.665
58	0.291	0.343	0.396	0.449	0.502	0.555	0.608	0.661	0.713
60	0.311	0.368	0.424	0.481	0.537	0.594	0.650	0.707	0.763
62	0.332	0.392	0.453	0.513	0.574	0.634	0.694	0.755	0.815
64	0.354	0.418	0.483	0.547	0.611	0.676	0.740	0.804	0.869
66	0.376	0.445	0.513	0.582	0.650	0.718	0.787	0.855	0.924
68	0.399	0.472	0.545	0.617	0.690	0.763	0.835	0.908	0.981
70	0.423	0.500	0.577	0.654	0.731	0.808	0.885	0.962	1.039
72	0.448	0.529	0.611	0.692	0.774	0.855	0.936	1.018	1.099
74	0.473	0.559	0.645	0.731	0.817	0.903	0.989	1.075	1.161
76	0.499	0.590	0.680	0.771	0.862	0.953	1.043	1.134	1.225
78	0.526	0.621	0.717	0.812	0.908	1.003	1.099	1.195	1.290
80	0.553	0.653	0.754	0.855	0.955	1.056	1.156	1.257	1.357
82	0.581	0.687	0.792	0.898	1.003	1.109	1.215	1.320	1.426
84	0.610	0.720	0.831	0.942	1.053	1.164	1.275	1.385	1.496
86	0.639	0.755	0.871	0.987	1.104	1.220	1.336	1.452	1.568
88	0.669	0.791	0.912	1.034	1.156	1.277	1.399	1.521	1.642

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM. (CM)	LENGTHS IN METRES								
	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5
10	0.023	0.024	0.026	0.027	0.029	0.031	0.032	0.034	0.035
12	0.033	0.035	0.037	0.040	0.042	0.044	0.046	0.049	0.051
14	0.045	0.048	0.051	0.054	0.057	0.060	0.063	0.066	0.069
16	0.058	0.062	0.066	0.070	0.074	0.078	0.082	0.086	0.090
18	0.074	0.079	0.084	0.089	0.094	0.099	0.104	0.109	0.115
20	0.091	0.097	0.104	0.110	0.116	0.123	0.129	0.135	0.141
22	0.110	0.118	0.125	0.133	0.141	0.148	0.156	0.163	0.171
24	0.131	0.140	0.149	0.158	0.167	0.176	0.185	0.195	0.204
26	0.154	0.165	0.175	0.186	0.196	0.207	0.218	0.228	0.239
28	0.179	0.191	0.203	0.216	0.228	0.240	0.252	0.265	0.277
30	0.205	0.219	0.233	0.247	0.262	0.276	0.290	0.304	0.318
32	0.233	0.249	0.265	0.281	0.298	0.314	0.330	0.346	0.362
34	0.263	0.281	0.300	0.318	0.336	0.354	0.372	0.390	0.409
36	0.295	0.316	0.336	0.356	0.377	0.397	0.417	0.438	0.458
38	0.329	0.352	0.374	0.397	0.420	0.442	0.465	0.488	0.510
40	0.364	0.390	0.415	0.440	0.465	0.490	0.515	0.540	0.565
42	0.402	0.429	0.457	0.485	0.513	0.540	0.568	0.596	0.623
44	0.441	0.471	0.502	0.532	0.563	0.593	0.623	0.654	0.684
46	0.482	0.515	0.548	0.582	0.615	0.648	0.681	0.715	0.748
48	0.525	0.561	0.597	0.633	0.670	0.706	0.742	0.778	0.814

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5
50	0.569	0.609	0.648	0.687	0.726	0.766	0.805	0.844	0.884
52	0.616	0.658	0.701	0.743	0.786	0.828	0.871	0.913	0.956
54	0.664	0.710	0.756	0.802	0.847	0.893	0.939	0.985	1.031
56	0.714	0.764	0.813	0.862	0.911	0.961	1.010	1.059	1.108
58	0.766	0.819	0.872	0.925	0.978	1.030	1.083	1.136	1.189
60	0.820	0.877	0.933	0.990	1.046	1.103	1.159	1.216	1.272
62	0.876	0.936	0.996	1.057	1.117	1.177	1.238	1.298	1.359
64	0.933	0.997	1.062	1.126	1.190	1.255	1.319	1.383	1.448
66	0.992	1.061	1.129	1.197	1.266	1.334	1.403	1.471	1.540
68	1.053	1.126	1.198	1.271	1.344	1.416	1.489	1.562	1.634
70	1.116	1.193	1.270	1.347	1.424	1.501	1.578	1.655	1.732
72	1.181	1.262	1.344	1.425	1.506	1.588	1.669	1.751	1.832
74	1.247	1.333	1.419	1.505	1.591	1.677	1.763	1.849	1.935
76	1.316	1.406	1.497	1.588	1.678	1.769	1.860	1.951	2.041
78	1.386	1.481	1.577	1.672	1.768	1.864	1.959	2.055	2.150
80	1.458	1.558	1.659	1.759	1.860	1.960	2.061	2.161	2.262
82	1.531	1.637	1.743	1.848	1.954	2.060	2.165	2.271	2.376
84	1.607	1.718	1.829	1.940	2.050	2.161	2.272	2.383	2.494
86	1.685	1.801	1.917	2.033	2.149	2.265	2.382	2.498	2.614
88	1.764	1.885	2.007	2.129	2.250	2.372	2.494	2.615	2.737

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3
10	0.037	0.038	0.040	0.042	0.043	0.045	0.046	0.048	0.049
12	0.053	0.055	0.058	0.060	0.062	0.064	0.067	0.069	0.071
14	0.072	0.075	0.079	0.082	0.085	0.088	0.091	0.094	0.097
16	0.094	0.099	0.103	0.107	0.111	0.115	0.119	0.123	0.127
18	0.120	0.125	0.130	0.135	0.140	0.145	0.150	0.155	0.160
20	0.148	0.154	0.160	0.167	0.173	0.179	0.185	0.192	0.198
22	0.179	0.186	0.194	0.201	0.209	0.217	0.224	0.232	0.239
24	0.213	0.222	0.231	0.240	0.249	0.258	0.267	0.276	0.285
26	0.250	0.260	0.271	0.281	0.292	0.303	0.313	0.324	0.334
28	0.289	0.302	0.314	0.326	0.339	0.351	0.363	0.376	0.388
30	0.332	0.346	0.360	0.375	0.389	0.403	0.417	0.431	0.445
32	0.378	0.394	0.410	0.426	0.442	0.458	0.475	0.491	0.507
34	0.427	0.445	0.463	0.481	0.499	0.518	0.536	0.554	0.572
36	0.478	0.499	0.519	0.539	0.560	0.580	0.601	0.621	0.641
38	0.533	0.556	0.578	0.601	0.624	0.646	0.669	0.692	0.714
40	0.591	0.616	0.641	0.666	0.691	0.716	0.741	0.767	0.792
42	0.651	0.679	0.707	0.734	0.762	0.790	0.817	0.845	0.873
44	0.715	0.745	0.775	0.806	0.836	0.867	0.897	0.928	0.958
46	0.781	0.814	0.848	0.881	0.914	0.947	0.981	1.014	1.047
48	0.850	0.887	0.923	0.959	0.995	1.031	1.068	1.104	1.140

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES AND LENGTH IN METRES

DIAM. (CM)	LENGTHS IN METRES								
	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3
50	0.923	0.96.	1.001	1.041	1.08	1.119	1.158	1.198	1.237
52	0.998	1.041	1.083	1.126	1.168	1.211	1.253	1.295	1.338
54	1.076	1.122	1.168	1.214	1.260	1.305	1.351	1.397	1.443
56	1.158	1.207	1.256	1.305	1.355	1.404	1.453	1.502	1.552
58	1.242	1.295	1.347	1.400	1.453	1.506	1.559	1.612	1.665
60	1.329	1.385	1.442	1.499	1.555	1.612	1.668	1.725	1.781
62	1.419	1.479	1.540	1.600	1.660	1.721	1.781	1.842	1.902
64	1.512	1.576	1.641	1.705	1.769	1.834	1.898	1.962	2.027
66	1.608	1.676	1.745	1.813	1.882	1.950	2.019	2.087	2.155
68	1.707	1.780	1.852	1.925	1.997	2.070	2.143	2.215	2.288
70	1.809	1.886	1.963	2.040	2.117	2.194	2.271	2.348	2.425
72	1.914	1.995	2.076	2.158	2.239	2.321	2.402	2.484	2.565
74	2.021	2.107	2.193	2.279	2.365	2.451	2.537	2.624	2.710
76	2.132	2.223	2.314	2.404	2.495	2.586	2.677	2.767	2.858
78	2.246	2.341	2.437	2.533	2.628	2.724	2.819	2.915	3.010
80	2.362	2.463	2.564	2.664	2.765	2.865	2.966	3.066	3.167
82	2.482	2.588	2.693	2.799	2.905	3.010	3.116	3.221	3.327
84	2.605	2.715	2.826	2.937	3.048	3.159	3.270	3.380	3.491
86	2.730	2.846	2.962	3.079	3.195	3.311	3.427	3.543	3.660
88	2.859	2.980	3.102	3.224	3.345	3.467	3.588	3.710	3.832

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1
10	0.051	0.053	0.054	0.056	0.057	0.059	0.06	0.062	0.064
12	0.074	0.076	0.078	0.080	0.083	0.085	0.087	0.089	0.092
14	0.100	0.103	0.106	0.109	0.112	0.115	0.119	0.122	0.125
16	0.131	0.135	0.139	0.143	0.147	0.151	0.155	0.159	0.163
18	0.165	0.170	0.176	0.181	0.186	0.191	0.196	0.201	0.206
20	0.204	0.210	0.217	0.223	0.229	0.236	0.242	0.248	0.254
22	0.247	0.255	0.262	0.270	0.277	0.285	0.293	0.300	0.308
24	0.294	0.303	0.312	0.321	0.330	0.339	0.348	0.357	0.366
26	0.345	0.356	0.366	0.377	0.388	0.398	0.409	0.419	0.430
28	0.400	0.413	0.425	0.437	0.449	0.462	0.474	0.486	0.499
30	0.459	0.474	0.488	0.502	0.516	0.530	0.544	0.558	0.573
32	0.523	0.539	0.555	0.571	0.587	0.603	0.619	0.635	0.651
34	0.590	0.608	0.626	0.645	0.663	0.681	0.699	0.717	0.735
36	0.662	0.682	0.702	0.723	0.743	0.763	0.784	0.804	0.824
38	0.737	0.760	0.783	0.805	0.828	0.851	0.873	0.896	0.919
40	0.817	0.842	0.867	0.892	0.917	0.942	0.968	0.993	1.018
42	0.901	0.928	0.956	0.984	1.011	1.039	1.067	1.094	1.122
44	0.988	1.019	1.049	1.080	1.110	1.140	1.171	1.201	1.232
46	1.080	1.113	1.147	1.180	1.213	1.246	1.280	1.313	1.346
48	1.176	1.212	1.249	1.285	1.321	1.357	1.393	1.430	1.466

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1
50	1.276	1.316	1.355	1.394	1.433	1.473	1.512	1.551	1.590
52	1.380	1.423	1.465	1.508	1.550	1.593	1.635	1.678	1.720
54	1.489	1.534	1.580	1.626	1.672	1.718	1.763	1.809	1.855
56	1.601	1.650	1.699	1.749	1.798	1.847	1.897	1.946	1.955
58	1.717	1.770	1.823	1.876	1.929	1.982	2.034	2.087	2.140
60	1.838	1.894	1.951	2.007	2.064	2.121	2.177	2.234	2.290
62	1.962	2.023	2.083	2.144	2.204	2.264	2.325	2.385	2.445
64	2.091	2.155	2.220	2.284	2.348	2.413	2.477	2.541	2.606
66	2.224	2.292	2.361	2.429	2.497	2.566	2.634	2.703	2.771
68	2.361	2.433	2.506	2.578	2.651	2.724	2.796	2.869	2.942
70	2.501	2.578	2.655	2.732	2.809	2.886	2.963	3.040	3.117
72	2.646	2.728	2.809	2.891	2.972	3.054	3.135	3.216	3.298
74	2.796	2.882	2.968	3.054	3.140	3.226	3.312	3.398	3.484
76	2.949	3.039	3.130	3.221	3.312	3.402	3.493	3.584	3.675
78	3.106	3.202	3.297	3.393	3.488	3.584	3.679	3.775	3.870
80	3.267	3.368	3.468	3.569	3.669	3.770	3.870	3.971	4.072
82	3.433	3.538	3.644	3.750	3.855	3.961	4.066	4.172	4.278
84	3.602	3.713	3.824	3.935	4.045	4.156	4.267	4.378	4.489
86	3.776	3.892	4.008	4.124	4.240	4.357	4.473	4.589	4.705
88	3.953	4.075	4.197	4.318	4.440	4.562	4.683	4.805	4.927

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9
10	0.065	0.067	0.068	0.070	0.071	0.073	0.075	0.076	0.078
12	0.094	0.096	0.098	0.101	0.103	0.105	0.107	0.110	0.112
14	0.128	0.131	0.134	0.137	0.140	0.143	0.146	0.149	0.152
16	0.167	0.171	0.175	0.179	0.183	0.187	0.191	0.195	0.199
18	0.211	0.216	0.221	0.226	0.232	0.237	0.242	0.247	0.252
20	0.261	0.267	0.273	0.280	0.286	0.292	0.298	0.305	0.311
22	0.316	0.323	0.331	0.338	0.346	0.354	0.361	0.369	0.376
24	0.375	0.385	0.394	0.403	0.412	0.421	0.430	0.439	0.448
26	0.441	0.451	0.462	0.473	0.483	0.494	0.504	0.515	0.526
28	0.511	0.523	0.536	0.548	0.560	0.573	0.585	0.597	0.610
30	0.587	0.601	0.615	0.629	0.643	0.657	0.672	0.686	0.700
32	0.668	0.684	0.700	0.716	0.732	0.748	0.764	0.780	0.796
34	0.754	0.772	0.790	0.808	0.826	0.844	0.863	0.881	0.899
36	0.845	0.865	0.886	0.906	0.926	0.947	0.967	0.987	1.008
38	0.941	0.964	0.987	1.009	1.032	1.055	1.077	1.100	1.123
40	1.043	1.068	1.093	1.118	1.144	1.169	1.194	1.219	1.244
42	1.150	1.178	1.205	1.233	1.261	1.288	1.316	1.344	1.372
44	1.262	1.292	1.323	1.353	1.384	1.414	1.445	1.475	1.505
46	1.379	1.413	1.446	1.479	1.512	1.546	1.579	1.612	1.645
48	1.502	1.538	1.574	1.611	1.647	1.683	1.719	1.755	1.791

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9
50	1.630	1.669	1.708	1.748	1.787	1.826	1.865	1.905	1.944
52	1.763	1.805	1.848	1.890	1.933	1.975	2.018	2.060	2.102
54	1.901	1.947	1.992	2.038	2.084	2.130	2.176	2.222	2.267
56	2.044	2.094	2.143	2.192	2.241	2.291	2.340	2.389	2.438
58	2.193	2.246	2.299	2.351	2.404	2.457	2.510	2.563	2.616
60	2.347	2.403	2.460	2.516	2.573	2.630	2.686	2.743	2.799
62	2.506	2.566	2.627	2.687	2.747	2.808	2.868	2.928	2.989
64	2.670	2.734	2.799	2.863	2.927	2.992	3.056	3.120	3.185
66	2.840	2.908	2.976	3.045	3.113	3.182	3.250	3.319	3.387
68	3.014	3.087	3.160	3.232	3.305	3.377	3.450	3.523	3.595
70	3.194	3.271	3.348	3.425	3.502	3.579	3.656	3.733	3.810
72	3.379	3.461	3.542	3.624	3.705	3.786	3.868	3.949	4.031
74	3.570	3.656	3.742	3.828	3.914	4.000	4.086	4.172	4.258
76	3.765	3.856	3.947	4.037	4.128	4.219	4.310	4.400	4.491
78	3.966	4.062	4.157	4.253	4.348	4.444	4.539	4.635	4.731
80	4.172	4.273	4.373	4.474	4.574	4.675	4.775	4.876	4.976
82	4.383	4.489	4.594	4.700	4.806	4.911	5.017	5.123	5.228
84	4.600	4.711	4.821	4.932	5.043	5.154	5.265	5.376	5.486
86	4.821	4.937	5.054	5.170	5.286	5.402	5.518	5.635	5.751
88	5.048	5.170	5.291	5.413	5.535	5.656	5.778	5.900	6.021

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	10.1	10.3	10.5	10.7	10.9	11.1	11.3	11.5	11.7
10	0.079	0.081	0.082	0.084	0.086	0.087	0.089	0.090	0.092
12	0.114	0.116	0.119	0.121	0.123	0.126	0.128	0.130	0.132
14	0.155	0.159	0.162	0.165	0.168	0.171	0.174	0.177	0.180
16	0.203	0.207	0.211	0.215	0.219	0.223	0.227	0.231	0.235
18	0.257	0.262	0.267	0.272	0.277	0.282	0.288	0.293	0.298
20	0.317	0.324	0.330	0.336	0.342	0.349	0.355	0.361	0.368
22	0.384	0.392	0.399	0.407	0.414	0.422	0.430	0.437	0.445
24	0.457	0.466	0.475	0.484	0.493	0.502	0.511	0.520	0.529
26	0.536	0.547	0.557	0.568	0.579	0.589	0.600	0.611	0.621
28	0.622	0.634	0.647	0.659	0.671	0.683	0.696	0.708	0.720
30	0.714	0.728	0.742	0.756	0.770	0.785	0.799	0.813	0.827
32	0.812	0.828	0.844	0.861	0.877	0.893	0.909	0.925	0.941
34	0.917	0.935	0.953	0.971	0.990	1.008	1.026	1.044	1.062
36	1.028	1.048	1.069	1.089	1.109	1.130	1.150	1.171	1.191
38	1.145	1.168	1.191	1.214	1.236	1.259	1.282	1.304	1.327
40	1.269	1.294	1.319	1.345	1.370	1.395	1.420	1.445	1.470
42	1.399	1.427	1.455	1.482	1.510	1.538	1.566	1.593	1.621
44	1.536	1.566	1.597	1.627	1.657	1.688	1.718	1.749	1.779
46	1.679	1.712	1.745	1.778	1.811	1.845	1.878	1.911	1.944
48	1.828	1.864	1.900	1.936	1.972	2.009	2.045	2.081	2.117

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	10.1	10.3	10.5	10.7	10.9	11.1	11.3	11.5	11.7
50	1.983	2.022	2.062	2.101	2.140	2.179	2.219	2.258	2.297
52	2.145	2.187	2.230	2.272	2.315	2.357	2.400	2.442	2.485
54	2.313	2.359	2.405	2.451	2.496	2.542	2.588	2.634	2.680
56	2.488	2.537	2.586	2.635	2.685	2.734	2.783	2.832	2.882
58	2.668	2.721	2.774	2.827	2.880	2.933	2.986	3.038	3.091
60	2.856	2.912	2.969	3.025	3.082	3.138	3.195	3.252	3.308
62	3.049	3.110	3.170	3.230	3.291	3.351	3.412	3.472	3.532
64	3.249	3.313	3.378	3.442	3.507	3.571	3.635	3.700	3.760
66	3.455	3.524	3.592	3.661	3.729	3.798	3.866	3.934	4.003
68	3.668	3.741	3.813	3.886	3.959	4.031	4.104	4.176	4.249
70	3.887	3.964	4.041	4.118	4.195	4.272	4.349	4.426	4.503
72	4.112	4.194	4.275	4.357	4.438	4.519	4.601	4.682	4.764
74	4.344	4.430	4.516	4.602	4.688	4.774	4.860	4.946	5.032
76	4.582	4.673	4.763	4.854	4.945	5.035	5.126	5.217	5.308
78	4.826	4.922	5.017	5.113	5.208	5.304	5.400	5.495	5.591
80	5.077	5.177	5.278	5.378	5.479	5.579	5.68o	5.781	5.881
82	5.334	5.439	5.545	5.651	5.756	5.862	5.968	6.073	6.179
84	5.597	5.708	5.819	5.930	6.041	6.151	6.262	6.373	6.484
86	5.867	5.983	6.099	6.215	6.332	6.448	6.564	6.680	6.796
88	6.143	6.265	6.386	6.508	6.630	6.751	6.873	6.994	7.116

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM. (CM)	LENGTHS IN METRES								
	11.9	**12.1**	**12.3**	**12.5**	**12.7**	**12.9**	**13.1**	**13.3**	**13.5**
10	0.093	0.095	0.097	0.098	0.100	0.101	0.103	0.104	0.106
12	0.135	0.137	0.139	0.141	0.144	0.146	0.148	0.150	0.153
14	0.183	0.186	0.189	0.192	0.196	0.199	0.202	0.205	0.208
16	0.239	0.243	0.247	0.251	0.255	0.259	0.263	0.267	0.271
18	0.303	0.308	0.313	0.318	0.323	0.328	0.333	0.338	0.344
20	0.374	0.380	0.386	0.393	0.399	0.405	0.412	0.418	0.424
22	0.452	0.460	0.468	0.475	0.483	0.490	0.498	0.506	0.513
24	0.538	0.547	0.556	0.565	0.575	0.584	0.593	0.602	0.611
26	0.632	0.642	0.653	0.664	0.674	0.685	0.696	0.706	0.717
28	0.733	0.745	0.757	0.770	0.782	0.794	0.807	0.819	0.831
30	0.841	0.855	0.869	0.884	0.898	0.912	0.926	0.940	0.954
32	0.957	0.973	0.989	1.005	1.021	1.037	1.054	1.070	1.086
34	1.080	1.099	1.117	1.135	1.153	1.171	1.189	1.208	1.226
36	1.211	1.232	1.252	1.272	1.293	1.313	1.333	1.354	1.374
38	1.350	1.372	1.395	1.418	1.440	1.463	1.486	1.508	1.531
40	1.495	1.521	1.546	1.571	1.596	1.621	1.646	1.671	1.696
42	1.649	1.676	1.704	1.732	1.760	1.787	1.815	1.843	1.870
44	1.809	1.840	1.870	1.901	1.931	1.961	1.992	2.022	2.053
46	1.978	2.011	2.044	2.077	2.111	2.144	2.177	2.210	2.244
48	2.153	2.190	2.226	2.262	2.298	2.334	2.371	2.407	2.443

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	11.9	12.1	12.3	12.5	12.7	12.9	13.1	13.3	13.5
50	2.337	2.376	2.415	2.454	2.494	2.533	2.572	2.611	2.651
52	2.527	2.570	2.612	2.655	2.697	2.740	2.782	2.825	2.867
54	2.725	2.771	2.817	2.863	2.909	2.954	3.000	3.046	3.092
56	2.931	2.980	3.029	3.079	3.128	3.177	3.227	3.276	3.325
58	3.144	3.197	3.250	3.303	3.355	3.408	3.461	3.514	3.567
60	3.365	3.421	3.478	3.534	3.591	3.647	3.704	3.760	3.817
62	3.593	3.653	3.713	3.774	3.834	3.895	3.955	4.015	4.076
64	3.828	3.893	3.957	4.021	4.086	4.150	4.214	4.279	4.343
66	4.071	4.140	4.208	4.276	4.345	4.413	4.482	4.550	4.619
68	4.322	4.394	4.467	4.540	4.612	4.685	4.758	4.830	4.903
70	4.580	4.657	4.734	4.811	4.888	4.965	5.041	5.118	5.195
72	4.845	4.927	5.008	5.089	5.171	5.252	5.334	5.415	5.497
74	5.118	5.204	5.290	5.376	5.462	5.548	5.634	5.720	5.806
76	5.398	5.489	5.580	5.671	5.761	5.852	5.943	6.033	6.124
78	5.686	5.782	5.877	5.973	6.069	6.164	6.260	6.355	6.451
80	5.982	6.082	6.183	6.283	6.384	6.484	6.585	6.685	6.786
82	6.284	6.390	6.496	6.601	6.707	6.813	6.918	7.024	7.129
84	6.595	6.706	6.816	6.927	7.038	7.149	7.260	7.371	7.481
86	6.912	7.029	7.145	7.261	7.377	7.493	7.610	7.726	7.842
88	7.238	7.359	7.481	7.603	7.724	7.846	7.968	8.089	8.211

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	13.7	13.9	14.1	14.3	14.5	14.7	14.9	15.1	15.3
10	0.108	0.109	0.111	0.112	0.114	0.115	0.117	0.119	0.120
12	0.155	0.157	0.159	0.162	0.164	0.166	0.169	0.171	0.173
14	0.211	0.214	0.217	0.220	0.223	0.226	0.229	0.232	0.236
16	0.275	0.279	0.283	0.288	0.292	0.296	0.300	0.304	0.308
18	0.349	0.354	0.359	0.364	0.369	0.374	0.379	0.384	0.389
20	0.430	0.437	0.443	0.449	0.456	0.462	0.468	0.474	0.481
22	0.521	0.528	0.536	0.544	0.551	0.559	0.566	0.574	0.582
24	0.620	0.629	0.638	0.647	0.656	0.665	0.674	0.683	0.692
26	0.727	0.738	0.749	0.759	0.770	0.780	0.791	0.802	0.812
28	0.844	0.856	0.868	0.881	0.893	0.905	0.917	0.930	0.942
30	0.968	0.983	0.997	1.011	1.025	1.039	1.053	1.067	1.081
32	1.102	1.118	1.134	1.150	1.166	1.182	1.198	1.214	1.230
34	1.244	1.262	1.280	1.298	1.316	1.335	1.353	1.371	1.389
36	1.394	1.415	1.435	1.456	1.476	1.496	1.517	1.537	1.557
38	1.554	1.576	1.599	1.622	1.644	1.667	1.690	1.713	1.735
40	1.722	1.747	1.772	1.797	1.822	1.847	1.872	1.898	1.923
42	1.898	1.926	1.953	1.981	2.009	2.037	2.064	2.092	2.120
44	2.083	2.114	2.144	2.174	2.205	2.235	2.266	2.296	2.326
46	2.277	2.310	2.343	2.377	2.410	2.443	2.476	2.509	2.543
48	2.479	2.515	2.551	2.588	2.624	2.660	2.696	2.732	2.769

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	13.7	13.9	14.1	14.3	14.5	14.7	14.9	15.1	15.3
50	2.690	2.729	2.769	2.808	2.847	2.886	2.926	2.965	3.004
52	2.909	2.952	2.994	3.037	3.079	3.122	3.164	3.207	3.249
54	3.136	3.183	3.229	3.275	3.321	3.367	3.412	3.458	3.504
56	3.374	3.424	3.473	3.522	3.571	3.621	3.670	3.719	3.768
58	3.620	3.672	3.725	3.778	3.831	3.884	3.937	3.990	4.042
60	3.874	3.930	3.987	4.043	4.100	4.156	4.213	4.269	4.326
62	4.136	4.197	4.257	4.317	4.378	4.438	4.498	4.559	4.619
64	4.407	4.472	4.536	4.600	4.665	4.729	4.793	4.858	4.922
66	4.687	4.755	4.824	4.892	4.961	5.029	5.098	5.166	5.234
68	4.975	5.048	5.121	5.193	5.266	5.339	5.411	5.484	5.556
70	5.272	5.349	5.426	5.503	5.580	5.657	5.734	5.811	5.888
72	5.578	5.659	5.741	5.822	5.904	5.985	6.067	6.148	6.229
74	5.892	5.978	6.064	6.150	6.236	6.322	6.408	6.494	6.580
76	6.215	6.306	6.396	6.487	6.578	6.669	6.759	6.850	6.941
78	6.546	6.642	6.737	6.833	6.929	7.024	7.120	7.215	7.311
80	6.886	6.987	7.087	7.188	7.288	7.389	7.490	7.590	7.691
82	7.235	7.341	7.446	7.552	7.657	7.763	7.869	7.974	8.080
84	7.592	7.703	7.814	7.925	8.036	8.146	8.257	8.368	8.479
86	7.958	8.074	8.190	8.307	8.423	8.539	8.655	8.771	8.887
88	8.333	8.454	8.576	8.697	8.819	8.941	9.062	9.184	9.306

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	15.5	15.7	15.9	16.1	16.3	16.5	16.7	16.9	17.1
10	0.122	0.123	0.125	0.126	0.128	0.13	0.131	0.133	0.134
12	0.175	0.178	0.180	0.182	0.184	0.187	0.189	0.191	0.193
14	0.239	0.242	0.245	0.248	0.251	0.254	0.257	0.260	0.263
16	0.312	0.316	0.320	0.324	0.328	0.332	0.336	0.340	0.344
18	0.394	0.400	0.405	0.410	0.415	0.420	0.425	0.430	0.435
20	0.487	0.493	0.500	0.506	0.512	0.518	0.525	0.531	0.537
22	0.589	0.597	0.604	0.612	0.620	0.627	0.635	0.642	0.650
24	0.701	0.710	0.719	0.728	0.737	0.746	0.755	0.765	0.774
26	0.823	0.834	0.844	0.855	0.865	0.876	0.887	0.897	0.908
28	0.954	0.967	0.979	0.991	1.004	1.016	1.028	1.041	1.053
30	1.096	1.110	1.124	1.138	1.152	1.166	1.180	1.195	1.209
32	1.247	1.263	1.279	1.295	1.311	1.327	1.343	1.359	1.375
34	1.407	1.425	1.444	1.462	1.480	1.498	1.516	1.534	1.553
36	1.578	1.598	1.618	1.639	1.659	1.679	1.700	1.720	1.741
38	1.758	1.781	1.803	1.826	1.849	1.871	1.894	1.917	1.939
40	1.948	1.973	1.998	2.023	2.048	2.073	2.099	2.124	2.149
42	2.147	2.175	2.203	2.231	2.258	2.286	2.314	2.341	2.369
44	2.357	2.387	2.418	2.448	2.478	2.509	2.539	2.570	2.600
46	2.576	2.609	2.642	2.676	2.709	2.742	2.775	2.809	2.842
48	2.805	2.841	2.877	2.913	2.950	2.986	3.022	3.058	3.094

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	15.5	15.7	15.9	16.1	16.3	16.5	16.7	16.9	17.1
50	3.043	3.083	3.122	3.161	3.200	3.240	3.279	3.318	3.358
52	3.292	3.334	3.377	3.419	3.462	3.504	3.547	3.589	3.632
54	3.550	3.596	3.641	3.687	3.733	3.779	3.825	3.870	3.916
56	3.818	3.867	3.916	3.965	4.015	4.064	4.113	4.162	4.212
58	4.095	4.148	4.201	4.254	4.307	4.359	4.412	4.465	4.518
60	4.383	4.439	4.496	4.552	4.609	4.665	4.722	4.778	4.835
62	4.680	4.740	4.800	4.861	4.921	4.981	5.042	5.102	5.163
64	4.986	5.051	5.115	5.179	5.244	5.308	5.372	5.437	5.501
66	5.303	5.371	5.440	5.508	5.577	5.645	5.713	5.782	5.850
68	5.629	5.702	5.774	5.847	5.920	5.992	6.065	6.138	6.210
70	5.965	6.042	6.119	6.196	6.273	6.350	6.427	6.504	6.581
72	6.311	6.392	6.474	6.555	6.637	6.718	6.799	6.881	6.962
74	6.666	6.752	6.838	6.924	7.010	7.096	7.182	7.268	7.354
76	7.032	7.122	7.213	7.304	7.394	7.485	7.576	7.667	7.757
78	7.406	7.502	7.598	7.693	7.789	7.884	7.980	8.075	8.171
80	7.791	7.892	7.992	8.093	8.193	8.294	8.394	8.495	8.595
82	8.186	8.291	8.397	8.502	8.608	8.714	8.819	8.925	9.031
84	8.590	8.701	8.811	8.922	9.033	9.144	9.255	9.366	9.476
86	9.004	9.120	9.236	9.352	9.468	9.585	9.701	9.817	9.933
88	9.427	9.549	9.671	9.792	9.914	10.036	10.157	10.279	10.400

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	17.3	17.5	17.7	17.9	18.1	18.3	18.5	18.7	18.9
10	0.136	0.137	0.139	0.141	0.142	0.144	0.145	0.147	0.148
12	0.196	0.198	0.200	0.202	0.205	0.207	0.209	0.211	0.214
14	0.266	0.269	0.272	0.276	0.279	0.282	0.285	0.288	0.291
16	0.348	0.352	0.356	0.360	0.364	0.368	0.372	0.376	0.380
18	0.440	0.445	0.450	0.455	0.461	0.466	0.471	0.476	0.481
20	0.543	0.550	0.556	0.562	0.569	0.575	0.581	0.587	0.594
22	0.658	0.665	0.673	0.680	0.688	0.696	0.703	0.711	0.718
24	0.783	0.792	0.801	0.810	0.819	0.828	0.837	0.846	0.855
26	0.919	0.929	0.940	0.950	0.961	0.972	0.982	0.993	1.003
28	1.065	1.078	1.090	1.102	1.115	1.127	1.139	1.151	1.164
30	1.223	1.237	1.251	1.265	1.279	1.294	1.308	1.322	1.336
32	1.391	1.407	1.424	1.440	1.456	1.472	1.488	1.504	1.520
34	1.571	1.589	1.607	1.625	1.643	1.661	1.680	1.698	1.716
36	1.761	1.781	1.802	1.822	1.842	1.863	1.883	1.903	1.924
38	1.962	1.985	2.007	2.030	2.053	2.075	2.098	2.121	2.143
40	2.174	2.199	2.224	2.249	2.275	2.300	2.325	2.350	3.375
42	2.397	2.425	2.452	2.480	2.508	2.535	2.563	2.591	2.618
44	2.631	2.661	2.691	2.722	2.752	2.783	2.813	2.843	2.874
46	2.875	2.908	2.942	2.975	3.008	3.041	3.075	3.108	3.141
48	3.131	3.167	3.203	3.239	3.275	3.311	3.348	3.384	3.420

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	17.3	17.5	17.7	17.9	18.1	18.3	18.5	18.7	18.9
50	3.397	3.436	3.475	3.515	3.554	3.593	3.632	3.672	3.711
52	3.674	3.717	3.759	3.801	3.844	3.886	3.929	3.971	4.014
54	3.962	4.008	4.054	4.099	4.145	4.191	4.237	4.283	4.329
56	4.261	4.310	4.360	4.409	4.458	4.507	4.557	4.606	4.655
58	4.571	4.624	4.676	4.729	4.782	4.835	4.888	4.941	4.994
60	4.891	4.948	5.005	5.061	5.118	5.174	5.231	5.287	5.344
62	5.223	5.283	5.344	5.404	5.465	5.525	5.585	5.646	5.706
64	5.565	5.630	5.694	5.758	5.823	5.887	5.951	6.016	6.080
66	5.919	5.987	6.056	6.124	6.192	6.261	6.329	6.398	6.466
68	6.283	6.355	6.428	6.501	6.573	6.646	6.719	6.791	6.864
70	6.658	6.735	6.812	6.889	6.966	7.043	7.120	7.197	7.274
72	7.044	7.125	7.207	7.288	7.369	7.451	7.532	7.614	7.695
74	7.440	7.526	7.612	7.699	7.785	7.871	7.957	8.043	8.129
76	7.848	7.939	8.030	8.120	8.211	8.302	8.392	8.483	8.574
78	8.267	8.362	8.458	8.553	8.649	8.744	8.840	8.936	9.031
80	8.696	8.796	8.897	8.998	9.098	9.199	9.299	9.400	9.500
82	9.136	9.242	9.347	9.453	9.559	9.664	9.770	9.876	9.981
84	9.587	9.698	9.809	9.920	10.031	10.141	10.252	10.363	10.474
86	10.049	10.165	10.282	10.398	10.514	10.630	10.746	10.862	10.979
88	10.522	10.644	10.765	10.887	11.009	11.130	11.252	11.374	11.495

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	**19.1**	**19.3**	**19.5**	**19.7**	**19.9**	**20.1**	**20.3**	**20.5**	**20.7**
10	0.150	0.152	0.153	0.155	0.156	0.158	0.159	0.161	0.163
12	0.216	0.218	0.221	0.223	0.225	0.227	0.230	0.232	0.234
14	0.294	0.297	0.300	0.303	0.306	0.309	0.312	0.316	0.319
16	0.384	0.388	0.392	0.396	0.400	0.404	0.408	0.412	0.416
18	0.486	0.491	0.496	0.501	0.506	0.511	0.517	0.522	0.527
20	0.600	0.606	0.613	0.619	0.625	0.631	0.638	0.644	0.650
22	0.726	0.734	0.741	0.749	0.756	0.764	0.772	0.779	0.787
24	0.864	0.873	0.882	0.891	0.900	0.909	0.918	0.927	0.936
26	1.014	1.025	1.035	1.046	1.057	1.067	1.078	1.088	1.099
28	1.176	1.188	1.201	1.213	1.225	1.238	1.250	1.262	1.275
30	1.350	1.364	1.378	1.393	1.407	1.421	1.435	1.449	1.463
32	1.536	1.552	1.568	1.584	1.600	1.617	1.633	1.649	1.665
34	1.734	1.752	1.770	1.789	1.807	1.825	1.843	1.861	1.879
36	1.944	1.964	1.985	2.005	2.026	2.046	2.066	2.087	2.107
38	2.166	2.189	2.212	2.234	2.257	2.280	2.302	2.325	2.348
40	2.400	2.425	2.450	2.476	2.501	2.526	2.551	2.576	2.601
42	2.646	2.674	2.702	2.729	2.757	2.785	2.812	2.840	2.868
44	2.904	2.935	2.965	2.995	3.026	3.056	3.087	3.117	3.147
46	3.174	3.207	3.241	3.274	3.307	3.340	3.374	3.407	3.440
48	3.456	3.492	3.529	3.565	3.601	3.637	3.673	3.710	3.746

TABLE 2

CUBIC METRE RULE

VOLUME IN CUBIC METRES FOR DIAMETER IN CENTIMETRES
AND LENGTH IN METRES

DIAM.	LENGTHS IN METRES								
(CM)	19.1	19.3	19.5	19.7	19.9	20.1	20.3	20.5	20.7
50	3.750	3.790	3.829	3.868	3.907	3.947	3.986	4.025	4.064
52	4.056	4.099	4.141	4.184	4.226	4.269	4.311	4.354	4.396
54	4.374	4.420	4.466	4.512	4.558	4.603	4.649	4.695	4.741
56	4.704	4.754	4.803	4.852	4.901	4.951	5.000	5.049	5.098
58	5.046	5.099	5.152	5.205	5.258	5.311	5.363	5.416	5.469
60	5.400	5.457	5.513	5.570	5.627	5.683	5.740	5.796	5.853
62	5.766	5.827	5.887	5.948	6.008	6.068	6.129	6.189	6.249
64	6.144	6.209	6.273	6.337	6.402	6.466	6.530	6.595	6.659
66	6.534	6.603	6.671	6.740	6.808	6.877	6.945	7.013	7.082
68	6.937	7.009	7.082	7.154	7.227	7.300	7.372	7.445	7.518
70	7.351	7.428	7.504	7.581	7.658	7.735	7.812	7.889	7.966
72	7.777	7.858	7.939	8.021	8.102	8.184	8.265	8.347	8.428
74	8.215	8.301	8.387	8.473	8.559	8.645	8.731	8.817	8.903
76	8.665	8.755	8.846	8.937	9.028	9.118	9.209	9.300	9.390
78	9.127	9.222	9.318	9.413	9.509	9.605	9.700	9.796	9.891
80	9.601	9.701	9.802	9.902	10.003	10.103	10.204	10.304	10.405
82	10.087	10.192	10.298	10.404	10.509	10.615	10.720	10.826	10.932
84	10.585	10.696	10.806	10.917	11.028	11.139	11.250	11.361	11.471
86	11.095	11.211	11.327	11.443	11.560	11.676	11.792	11.908	12.024
88	11.617	11.738	11.860	11.982	12.103	12.225	12.347	12.468	12.590

TABLE 3

DIAMETER REDUCTIONS FOR INTERIOR DEFECTS IN CUBIC MEASUREMENT

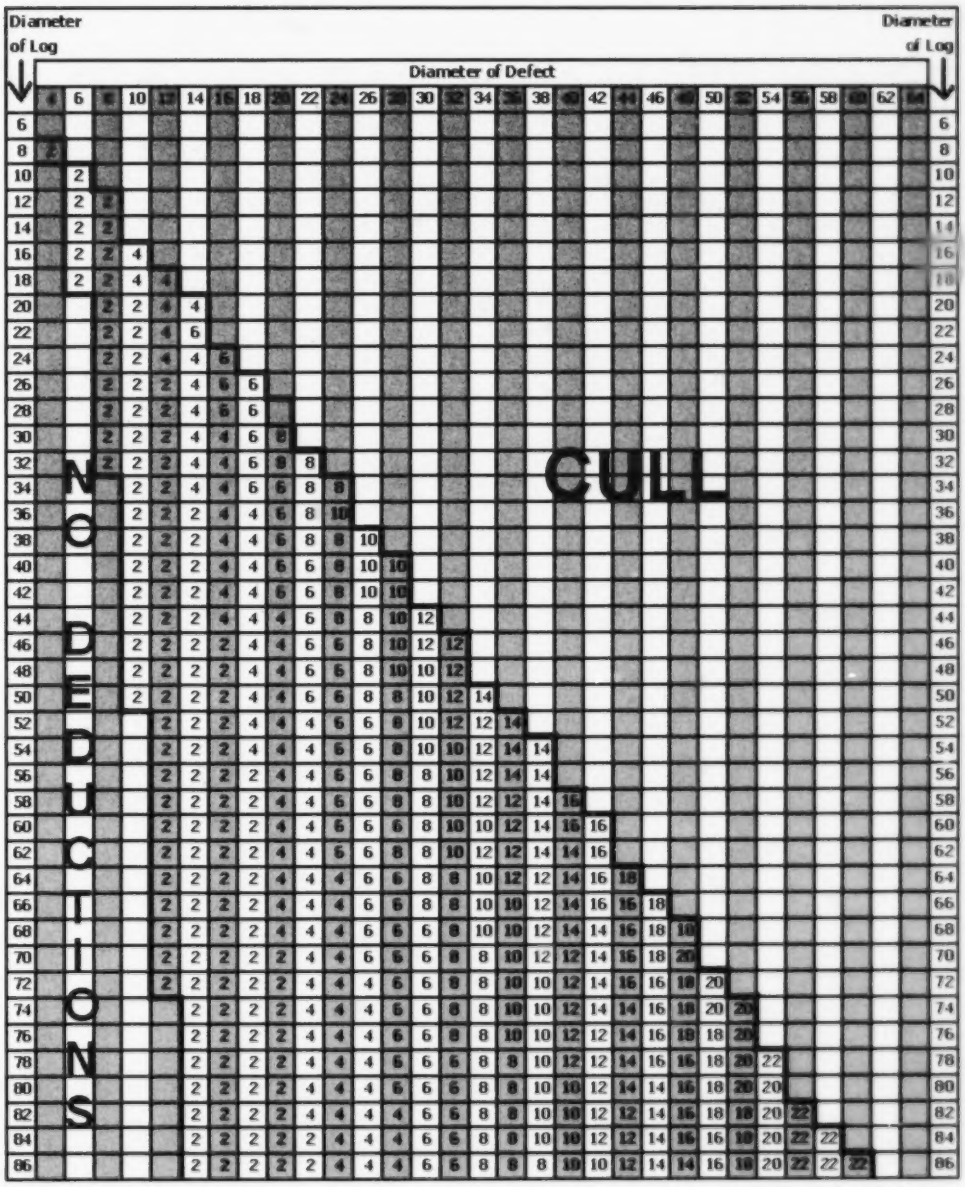


TABLE 4

DIAMETER REDUCTIONS FOR PERCENTAGE DEFECTS

IN CUBIC MEASUREMENTS

DIAM. OF LOG	PERCENTAGE DEFECTS					DIAM. OF LOG
	10	25	33 ⅓	50	66 ⅔	
10	-	2	2	4	4	10
12	-	2	2	4	4	12
14	-	2	2	4	6	14
16	-	2	2	4	6	16
18	-	2	4	6	8	18
20	2	2	4	6	8	20
22	2	2	4	6	10	22
24	2	4	4	8	10	24
26	2	4	4	8	12	26
28	2	4	6	8	12	28
30	2	4	6	8	12	30
32	2	4	6	10	14	32
34	2	4	6	10	14	34
36	2	4	6	10	16	36
38	2	6	6	12	16	38
40	2	6	8	12	16	40
42	2	6	8	12	18	42
44	2	6	8	12	18	44
46	2	6	8	14	20	46
48	2	6	8	14	20	48
50	2	6	10	14	22	50
52	2	6	10	16	22	52
54	2	8	10	16	22	54
56	2	8	10	16	24	56
58	2	8	10	18	24	58
60	4	8	12	18	26	60
62	4	8	12	18	26	62
64	4	8	12	18	28	64
66	4	8	12	20	28	66
68	4	10	12	20	28	68
70	4	10	12	20	30	70
72	4	10	14	22	30	72
74	4	10	14	22	32	74
76	4	10	14	22	32	76
78	4	10	14	22	32	78
80	4	10	14	24	34	80
82	4	10	16	24	34	82
84	4	12	16	24	36	84
86	4	12	16	26	36	86
88	4	12	16	26	38	88

TABLE 5

STACKED WOOD – SHOWING VOLUMES IN STACKED CUBIC METRES FOR VARIOUS DIAMETER CLASSES AND LENGTHS OF ROUGH AND PEELED WOOD

ROUGH WOOD			PEELED WOOD		
DIAMETER	1.26m	2.54m	1.26m	2.54m	DIAMETER
6	0.01	0.01	0.01	0.01	6
8	0.01	0.02	0.01	0.02	8
10	0.02	0.03	0.01	0.03	10
12	0.02	0.04	0.02	0.04	12
14	0.03	0.06	0.02	0.05	14
16	0.04	0.08	0.03	0.07	16
18	0.05	0.10	0.04	0.08	18
20	0.06	0.12	0.05	0.10	20
22	0.07	0.15	0.06	0.12	22
24	0.09	0.17	0.07	0.15	24
26	0.10	0.20	0.09	0.17	26
28	0.12	0.23	0.10	0.20	28
30	0.13	0.27	0.11	0.23	30
32	0.15	0.31	0.13	0.26	32
34	0.17	0.35	0.15	0.30	34
36	0.19	0.39	0.16	0.33	36
38	0.21	0.43	0.18	0.37	38
40	0.24	0.48	0.20	0.41	40
42	0.26	0.53	0.22	0.45	42
44	0.29	0.58	0.25	0.49	44
46	0.31	0.63	0.27	0.54	46
48	0.34	0.69	0.29	0.59	48
50	0.37	0.75	0.32	0.64	50

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.50	1.52	1.54	1.56	1.58	1.60	1.62	1.64
HT								
1.00	1.89	1.92	1.94	1.97	1.99	2.02	2.04	2.07
	3.81	3.86	3.91	3.96	4.01	4.06	4.11	4.17
1.01	1.91	1.93	1.96	1.99	2.01	2.04	2.06	2.09
	3.85	3.90	3.95	4.00	4.05	4.10	4.16	4.21
1.02	1.93	1.95	1.98	2.00	2.03	2.06	2.08	2.11
	3.89	3.94	3.99	4.04	4.09	4.15	4.20	4.25
1.03	1.95	1.97	2.00	2.02	2.05	2.08	2.10	2.13
	3.92	3.98	4.03	4.08	4.13	4.19	4.24	4.29
1.04	1.97	1.99	2.02	2.04	2.07	2.10	2.12	2.15
	3.96	4.02	4.07	4.12	4.17	4.23	4.28	4.33
1.05	1.98	2.01	2.04	2.06	2.09	2.12	2.14	2.17
	4.00	4.05	4.11	4.16	4.21	4.27	4.32	4.37
1.06	2.00	2.03	2.06	2.08	2.11	2.14	2.16	2.19
	4.04	4.09	4.15	4.20	4.25	4.31	4.36	4.42
1.07	2.02	2.05	2.08	2.10	2.13	2.16	2.18	2.21
	4.08	4.13	4.19	4.24	4.29	4.35	4.40	4.46
1.08	2.04	2.07	2.10	2.12	2.15	2.18	2.20	2.23
	4.11	4.17	4.22	4.28	4.33	4.39	4.44	4.50
1.09	2.06	2.09	2.12	2.14	2.17	2.20	2.22	2.25
	4.15	4.21	4.26	4.32	4.37	4.43	4.49	4.54
1.10	2.08	2.11	2.13	2.16	2.19	2.22	2.25	2.27
	4.19	4.25	4.30	4.36	4.41	4.47	4.53	4.58
1.11	2.10	2.13	2.15	2.18	2.21	2.24	2.27	2.29
	4.23	4.29	4.34	4.40	4.45	4.51	4.57	4.62
1.12	2.12	2.15	2.17	2.20	2.23	2.26	2.29	2.31
	4.27	4.32	4.38	4.44	4.49	4.55	4.61	4.67
1.13	2.14	2.16	2.19	2.22	2.25	2.28	2.31	2.34
	4.31	4.36	4.42	4.48	4.53	4.59	4.65	4.71
1.14	2.15	2.18	2.21	2.24	2.27	2.30	2.33	2.36
	4.34	4.40	4.46	4.52	4.58	4.63	4.69	4.75
1.15	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38
	4.38	4.44	4.50	4.56	4.62	4.67	4.73	4.79
1.16	2.19	2.22	2.25	2.28	2.31	2.34	2.37	2.40
	4.42	4.48	4.54	4.60	4.66	4.71	4.77	4.83

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.50	1.52	1.54	1.56	1.58	1.60	1.62	1.64
HT								
1.17	2.21	2.24	2.27	2.30	2.33	2.36	2.39	2.42
	4.46	4.52	4.58	4.64	4.70	4.75	4.81	4.87
1.18	2.23	2.26	2.29	2.32	2.35	2.38	2.41	2.44
	4.50	4.56	4.62	4.68	4.74	4.80	4.86	4.92
1.19	2.25	2.28	2.31	2.34	2.37	2.40	2.43	2.46
	4.53	4.59	4.65	4.72	4.78	4.84	4.90	4.96
1.20	2.27	2.30	2.33	2.36	2.39	2.42	2.45	2.48
	4.57	4.63	4.69	4.75	4.82	4.88	4.94	5.00
1.21	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.50
	4.61	4.67	4.73	4.79	4.86	4.92	4.98	5.04
1.22	2.31	2.34	2.37	2.40	2.43	2.46	2.49	2.52
	4.65	4.71	4.77	4.83	4.90	4.96	5.02	5.08
1.23	2.32	2.36	2.39	2.42	2.45	2.48	2.51	2.54
	4.69	4.75	4.81	4.87	4.94	5.00	5.06	5.12
1.24	2.34	2.37	2.41	2.44	2.47	2.50	2.53	2.56
	4.72	4.79	4.85	4.91	4.98	5.04	5.10	5.17
1.25	2.36	2.39	2.43	2.46	2.49	2.52	2.55	2.58
	4.76	4.83	4.89	4.95	5.02	5.08	5.14	5.21
1.26	2.38	2.41	2.44	2.48	2.51	2.54	2.57	2.60
	4.80	4.86	4.93	4.99	5.06	5.12	5.18	5.25
1.27	2.40	2.43	2.46	2.50	2.53	2.56	2.59	2.62
	4.84	4.90	4.97	5.03	5.10	5.16	5.23	5.29
1.28	2.42	2.45	2.48	2.52	2.55	2.58	2.61	2.64
	4.88	4.94	5.01	5.07	5.14	5.20	5.27	5.33
1.29	2.44	2.47	2.50	2.54	2.57	2.60	2.63	2.67
	4.91	4.98	5.05	5.11	5.18	5.24	5.31	5.37
1.30	2.46	2.49	2.52	2.56	2.59	2.62	2.65	2.69
	4.95	5.02	5.09	5.15	5.22	5.28	5.35	5.42
1.31	2.48	2.51	2.54	2.57	2.61	2.64	2.67	2.71
	4.99	5.06	5.12	5.19	5.26	5.32	5.39	5.46
1.32	2.49	2.53	2.56	2.59	2.63	2.66	2.69	2.73
	5.03	5.10	5.16	5.23	5.30	5.36	5.43	5.50
1.33	2.51	2.55	2.58	2.61	2.65	2.68	2.71	2.75
	5.07	5.13	5.20	5.27	5.34	5.41	5.47	5.54

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80
HT								
1.00	2.09	2.12	2.14	2.17	2.19	2.22	2.24	2.27
	4.22	4.27	4.32	4.37	4.42	4.47	4.52	4.57
1.01	2.11	2.14	2.16	2.19	2.21	2.24	2.27	2.29
	4.26	4.31	4.36	4.41	4.46	4.52	4.57	4.62
1.02	2.13	2.16	2.18	2.21	2.24	2.26	2.29	2.31
	4.30	4.35	4.40	4.46	4.51	4.56	4.61	4.66
1.03	2.15	2.18	2.21	2.23	2.26	2.28	2.31	2.34
	4.34	4.40	4.45	4.50	4.55	4.60	4.66	4.71
1.04	2.18	2.20	2.23	2.25	2.28	2.31	2.33	2.36
	4.39	4.44	4.49	4.54	4.60	4.65	4.70	4.75
1.05	2.20	2.22	2.25	2.28	2.30	2.33	2.35	2.38
	4.43	4.48	4.53	4.59	4.64	4.69	4.75	4.80
1.06	2.22	2.24	2.27	2.30	2.32	2.35	2.38	2.40
	4.47	4.52	4.58	4.63	4.68	4.74	4.79	4.85
1.07	2.24	2.26	2.29	2.32	2.35	2.37	2.40	2.43
	4.51	4.57	4.62	4.67	4.73	4.78	4.84	4.89
1.08	2.26	2.29	2.31	2.34	2.37	2.40	2.42	2.45
	4.55	4.61	4.66	4.72	4.77	4.83	4.88	4.94
1.09	2.28	2.31	2.33	2.36	2.39	2.42	2.44	2.47
	4.60	4.65	4.71	4.76	4.82	4.87	4.93	4.98
1.10	2.30	2.33	2.36	2.38	2.41	2.44	2.47	2.49
	4.64	4.69	4.75	4.81	4.86	4.92	4.97	5.03
1.11	2.32	2.35	2.38	2.41	2.43	2.46	2.49	2.52
	4.68	4.74	4.79	4.85	4.91	4.96	5.02	5.07
1.12	2.34	2.37	2.40	2.43	2.46	2.48	2.51	2.54
	4.72	4.78	4.84	4.89	4.95	5.01	5.06	5.12
1.13	2.36	2.39	2.42	2.45	2.48	2.51	2.53	2.56
	4.76	4.82	4.88	4.94	4.99	5.05	5.11	5.17
1.14	2.38	2.41	2.44	2.47	2.50	2.53	2.56	2.59
	4.81	4.86	4.92	4.98	5.04	5.10	5.15	5.21
1.15	2.41	2.43	2.46	2.49	2.52	2.55	2.58	2.61
	4.85	4.91	4.97	5.02	5.08	5.14	5.20	5.26
1.16	2.43	2.46	2.48	2.51	2.54	2.57	2.60	2.63
	4.89	4.95	5.01	5.07	5.13	5.19	5.24	5.30

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80
HT								
1.17	2.45	2.48	2.51	2.54	2.57	2.59	2.62	2.65
	4.93	4.99	5.05	5.11	5.17	5.23	5.29	5.35
1.18	2.47	2.50	2.53	2.56	2.59	2.62	2.65	2.68
	4.98	5.04	5.10	5.16	5.22	5.28	5.34	5.39
1.19	2.49	2.52	2.55	2.58	2.61	2.64	2.67	2.70
	5.02	5.08	5.14	5.20	5.26	5.32	5.38	5.44
1.20	2.51	2.54	2.57	2.60	2.63	2.66	2.69	2.72
	5.06	5.12	5.18	5.24	5.30	5.36	5.43	5.49
1.21	2.53	2.56	2.59	2.62	2.65	2.68	2.71	2.74
	5.10	5.16	5.22	5.29	5.35	5.41	5.47	5.53
1.22	2.55	2.58	2.61	2.64	2.67	2.71	2.74	2.77
	5.14	5.21	5.27	5.33	5.39	5.45	5.52	5.58
1.23	2.57	2.60	2.63	2.67	2.70	2.73	2.76	2.79
	5.19	5.25	5.31	5.37	5.44	5.50	5.56	5.62
1.24	2.59	2.62	2.66	2.69	2.72	2.75	2.78	2.81
	5.23	5.29	5.35	5.42	5.48	5.54	5.61	5.67
1.25	2.61	2.65	2.68	2.71	2.74	2.77	2.80	2.84
	5.27	5.33	5.40	5.46	5.52	5.59	5.65	5.72
1.26	2.64	2.67	2.70	2.73	2.76	2.79	2.83	2.86
	5.31	5.38	5.44	5.50	5.57	5.63	5.70	5.76
1.27	2.66	2.69	2.72	2.75	2.78	2.82	2.85	2.88
	5.35	5.42	5.48	5.55	5.61	5.68	5.74	5.81
1.28	2.68	2.71	2.74	2.77	2.81	2.84	2.87	2.90
	5.40	5.46	5.53	5.59	5.66	5.72	5.79	5.85
1.29	2.70	2.73	2.76	2.80	2.83	2.86	2.89	2.93
	5.44	5.50	5.57	5.64	5.70	5.77	5.83	5.90
1.30	2.72	2.75	2.78	2.82	2.85	2.88	2.92	2.95
	5.48	5.55	5.61	5.68	5.75	5.81	5.88	5.94
1.31	2.74	2.77	2.81	2.84	2.87	2.91	2.94	2.97
	5.52	5.59	5.66	5.72	5.79	5.86	5.92	5.99
1.32	2.76	2.79	2.83	2.86	2.89	2.93	2.96	2.99
	5.57	5.63	5.70	5.77	5.83	5.90	5.97	6.04
1.33	2.78	2.82	2.85	2.88	2.92	2.95	2.98	3.02
	5.61	5.68	5.74	5.81	5.88	5.95	6.01	6.08

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96
HT								
1.00	2.29	2.32	2.34	2.37	2.39	2.42	2.44	2.47
	4.62	4.67	4.72	4.78	4.83	4.88	4.93	4.98
1.01	2.32	2.34	2.37	2.39	2.42	2.44	2.47	2.49
	4.67	4.72	4.77	4.82	4.87	4.93	4.98	5.03
1.02	2.34	2.36	2.39	2.42	2.44	2.47	2.49	2.52
	4.72	4.77	4.82	4.87	4.92	4.97	5.03	5.08
1.03	2.36	2.39	2.41	2.44	2.47	2.49	2.52	2.54
	4.76	4.81	4.87	4.92	4.97	5.02	5.08	5.13
1.04	2.38	2.41	2.44	2.46	2.49	2.52	2.54	2.57
	4.81	4.86	4.91	4.97	5.02	5.07	5.12	5.18
1.05	2.41	2.43	2.46	2.49	2.51	2.54	2.57	2.59
	4.85	4.91	4.96	5.01	5.07	5.12	5.17	5.23
1.06	2.43	2.46	2.48	2.51	2.54	2.56	2.59	2.62
	4.90	4.95	5.01	5.06	5.12	5.17	5.22	5.28
1.07	2.45	2.48	2.51	2.53	2.56	2.59	2.62	2.64
	4.95	5.00	5.06	5.11	5.16	5.22	5.27	5.33
1.08	2.48	2.50	2.53	2.56	2.59	2.61	2.64	2.67
	4.99	5.05	5.10	5.16	5.21	5.27	5.32	5.38
1.09	2.50	2.53	2.55	2.58	2.61	2.64	2.66	2.69
	5.04	5.09	5.15	5.20	5.26	5.32	5.37	5.43
1.10	2.52	2.55	2.58	2.61	2.63	2.66	2.69	2.72
	5.09	5.14	5.20	5.25	5.31	5.36	5.42	5.48
1.11	2.55	2.57	2.60	2.63	2.66	2.69	2.71	2.74
	5.13	5.19	5.24	5.30	5.36	5.41	5.47	5.53
1.12	2.57	2.60	2.62	2.65	2.68	2.71	2.74	2.77
	5.18	5.23	5.29	5.35	5.41	5.46	5.52	5.58
1.13	2.59	2.62	2.65	2.68	2.71	2.73	2.76	2.79
	5.22	5.28	5.34	5.40	5.45	5.51	5.57	5.63
1.14	2.61	2.64	2.67	2.70	2.73	2.76	2.79	2.82
	5.27	5.33	5.39	5.44	5.50	5.56	5.62	5.68
1.15	2.64	2.67	2.70	2.72	2.75	2.78	2.81	2.84
	5.32	5.37	5.43	5.49	5.55	5.61	5.67	5.73
1.16	2.66	2.69	2.72	2.75	2.78	2.81	2.84	2.86
	5.36	5.42	5.48	5.54	5.60	5.66	5.72	5.77

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.82	1.84	1.86	1.88	1.9	1.92	1.94	1.96
HT								
1.17	2.68	2.71	2.74	2.77	2.80	2.83	2.86	2.89
	5.41	5.47	5.53	5.59	5.65	5.71	5.77	5.82
1.18	2.71	2.74	2.77	2.80	2.82	2.85	2.88	2.91
	5.45	5.51	5.57	5.63	5.69	5.75	5.81	5.87
1.19	2.73	2.76	2.79	2.82	2.85	2.88	2.91	2.94
	5.50	5.56	5.62	5.68	5.74	5.80	5.86	5.92
1.20	2.75	2.78	2.81	2.84	2.87	2.90	2.93	2.96
	5.55	5.61	5.67	5.73	5.79	5.85	5.91	5.97
1.21	2.77	2.81	2.84	2.87	2.90	2.93	2.96	2.99
	5.59	5.66	5.72	5.78	5.84	5.90	5.96	6.02
1.22	2.80	2.83	2.86	2.89	2.92	2.95	2.98	3.01
	5.64	5.70	5.76	5.83	5.89	5.95	6.01	6.07
1.23	2.82	2.85	2.88	2.91	2.94	2.98	3.01	3.04
	5.69	5.75	5.81	5.87	5.94	6.00	6.06	6.12
1.24	2.84	2.87	2.91	2.94	2.97	3.00	3.03	3.06
	5.73	5.80	5.86	5.92	5.98	6.05	6.11	6.17
1.25	2.87	2.90	2.93	2.96	2.99	3.02	3.06	3.09
	5.78	5.84	5.91	5.97	6.03	6.10	6.16	6.22
1.26	2.89	2.92	2.95	2.98	3.02	3.05	3.08	3.11
	5.82	5.89	5.95	6.02	6.08	6.14	6.21	6.27
1.27	2.91	2.94	2.98	3.01	3.04	3.07	3.10	3.14
	5.87	5.94	6.00	6.06	6.13	6.19	6.26	6.32
1.28	2.94	2.97	3.00	3.03	3.06	3.10	3.13	3.16
	5.92	5.98	6.05	6.11	6.18	6.24	6.31	6.37
1.29	2.96	2.99	3.02	3.06	3.09	3.12	3.15	3.19
	5.96	6.03	6.09	6.16	6.23	6.29	6.36	6.42
1.30	2.98	3.01	3.05	3.08	3.11	3.14	3.18	3.21
	6.01	6.08	6.14	6.21	6.27	6.34	6.41	6.47
1.31	3.00	3.04	3.07	3.10	3.14	3.17	3.20	3.24
	6.06	6.12	6.19	6.26	6.32	6.39	6.46	6.52
1.32	3.03	3.06	3.09	3.13	3.16	3.19	3.23	3.26
	6.10	6.17	6.24	6.30	6.37	6.44	6.50	6.57
1.33	3.05	3.08	3.12	3.15	3.18	3.22	3.25	3.28
	6.15	6.22	6.28	6.35	6.42	6.49	6.55	6.62

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.98	2.00	2.02	2.04	2.06	2.08	2.10	2.12
HT								
1.00	2.49	2.52	2.55	2.57	2.60	2.62	2.65	2.67
	5.03	5.08	5.13	5.18	5.23	5.28	5.33	5.38
1.01	2.52	2.55	2.57	2.60	2.62	2.65	2.67	2.70
	5.08	5.13	5.18	5.23	5.28	5.34	5.39	5.44
1.02	2.54	2.57	2.60	2.62	2.65	2.67	2.70	2.72
	5.13	5.18	5.23	5.29	5.34	5.39	5.44	5.49
1.03	2.57	2.60	2.62	2.65	2.67	2.70	2.73	2.75
	5.18	5.23	5.28	5.34	5.39	5.44	5.49	5.55
1.04	2.59	2.62	2.65	2.67	2.70	2.73	2.75	2.78
	5.23	5.28	5.34	5.39	5.44	5.49	5.55	5.60
1.05	2.62	2.65	2.67	2.70	2.73	2.75	2.78	2.80
	5.28	5.33	5.39	5.44	5.49	5.55	5.60	5.65
1.06	2.64	2.67	2.70	2.72	2.75	2.78	2.80	2.83
	5.33	5.38	5.44	5.49	5.55	5.60	5.65	5.71
1.07	2.67	2.70	2.72	2.75	2.78	2.80	2.83	2.86
	5.38	5.44	5.49	5.54	5.60	5.65	5.71	5.76
1.08	2.69	2.72	2.75	2.78	2.80	2.83	2.86	2.88
	5.43	5.49	5.54	5.60	5.65	5.71	5.76	5.82
1.09	2.72	2.75	2.77	2.80	2.83	2.86	2.88	2.91
	5.48	5.54	5.59	5.65	5.70	5.76	5.81	5.87
1.10	2.74	2.77	2.80	2.83	2.86	2.88	2.91	2.94
	5.53	5.59	5.64	5.70	5.76	5.81	5.87	5.92
1.11	2.77	2.80	2.83	2.85	2.88	2.91	2.94	2.97
	5.58	5.64	5.70	5.75	5.81	5.86	5.92	5.98
1.12	2.79	2.82	2.85	2.88	2.91	2.94	2.96	2.99
	5.63	5.69	5.75	5.80	5.86	5.92	5.97	6.03
1.13	2.82	2.85	2.88	2.90	2.93	2.96	2.99	3.02
	5.68	5.74	5.80	5.86	5.91	5.97	6.03	6.08
1.14	2.84	2.87	2.90	2.93	2.96	2.99	3.02	3.05
	5.73	5.79	5.85	5.91	5.96	6.02	6.08	6.14
1.15	2.87	2.90	2.93	2.96	2.98	3.01	3.04	3.07
	5.78	5.84	5.90	5.96	6.02	6.08	6.13	6.19
1.16	2.89	2.92	2.95	2.98	3.01	3.04	3.07	3.10
	5.83	5.89	5.95	6.01	6.07	6.13	6.19	6.25

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	1.98	2.00	2.02	2.04	2.06	2.08	2.10	2.12
HT								
1.17	2.92	2.95	2.98	3.01	3.04	3.07	3.10	3.13
	5.88	5.94	6.00	6.06	6.12	6.18	6.24	6.30
1.18	2.94	2.97	3.00	3.03	3.06	3.09	3.12	3.15
	5.93	5.99	6.05	6.11	6.17	6.23	6.29	6.35
1.19	2.97	3.00	3.03	3.06	3.09	3.12	3.15	3.18
	5.98	6.05	6.11	6.17	6.23	6.29	6.35	6.41
1.20	2.99	3.02	3.05	3.08	3.11	3.14	3.18	3.21
	6.04	6.10	6.16	6.22	6.28	6.34	6.40	6.46
1.21	3.02	3.05	3.08	3.11	3.14	3.17	3.20	3.23
	6.09	6.15	6.21	6.27	6.33	6.39	6.45	6.52
1.22	3.04	3.07	3.11	3.14	3.17	3.20	3.23	3.26
	6.14	6.20	6.26	6.32	6.38	6.45	6.51	6.57
1.23	3.07	3.10	3.13	3.16	3.19	3.22	3.25	3.29
	6.19	6.25	6.31	6.37	6.44	6.50	6.56	6.62
1.24	3.09	3.12	3.16	3.19	3.22	3.25	3.28	3.31
	6.24	6.30	6.36	6.43	6.49	6.55	6.61	6.68
1.25	3.12	3.15	3.18	3.21	3.24	3.28	3.31	3.34
	6.29	6.35	6.41	6.48	6.54	6.60	6.67	6.73
1.26	3.14	3.18	3.21	3.24	3.27	3.30	3.33	3.37
	6.34	6.40	6.46	6.53	6.59	6.66	6.72	6.78
1.27	3.17	3.20	3.23	3.26	3.30	3.33	3.36	3.39
	6.39	6.45	6.52	6.58	6.65	6.71	6.77	6.84
1.28	3.19	3.23	3.26	3.29	3.32	3.35	3.39	3.42
	6.44	6.50	6.57	6.63	6.70	6.76	6.83	6.89
1.29	3.22	3.25	3.28	3.32	3.35	3.38	3.41	3.45
	6.49	6.55	6.62	6.68	6.75	6.82	6.88	6.95
1.30	3.24	3.28	3.31	3.34	3.37	3.41	3.44	3.47
	6.54	6.60	6.67	6.74	6.80	6.87	6.93	7.00
1.31	3.27	3.30	3.33	3.37	3.40	3.43	3.47	3.50
	6.59	6.65	6.72	6.79	6.85	6.92	6.99	7.05
1.32	3.29	3.33	3.36	3.39	3.43	3.46	3.49	3.53
	6.54	6.71	6.77	6.84	6.91	6.97	7.04	7.11
1.33	3.32	3.35	3.39	3.42	3.45	3.49	3.52	3.55
	6.69	6.76	6.82	6.89	6.96	7.03	7.09	7.16

TABLE 6

STACKED CUBIC METRE VOLUME

1.22 AND 2.54 METRES IN LENGTH

LTH	2.14	2.16	2.18	2.20	2.22	2.24	2.26	2.28
HT								
1.00	2.70	2.72	2.75	2.77	2.80	2.82	2.85	2.87
	5.44	5.49	5.54	5.59	5.64	5.69	5.74	5.79
1.01	2.72	2.75	2.77	2.80	2.83	2.85	2.88	2.90
	5.49	5.54	5.59	5.64	5.70	5.75	5.80	5.85
1.02	2.75	2.78	2.80	2.83	2.85	2.88	2.90	2.93
	5.54	5.60	5.65	5.70	5.75	5.80	5.86	5.91
1.03	2.78	2.80	2.83	2.86	2.88	2.91	2.93	2.96
	5.60	5.65	5.70	5.76	5.81	5.86	5.91	5.96
1.04	2.80	2.83	2.86	2.88	2.91	2.94	2.96	2.99
	5.65	5.71	5.76	5.81	5.86	5.92	5.97	6.02
1.05	2.83	2.86	2.88	2.91	2.94	2.96	2.99	3.02
	5.71	5.76	5.81	5.87	5.92	5.97	6.03	6.08
1.06	2.86	2.88	2.91	2.94	2.97	2.99	3.02	3.05
	5.76	5.82	5.87	5.92	5.98	6.03	6.08	6.14
1.07	2.89	2.91	2.94	2.97	2.99	3.02	3.05	3.07
	5.82	5.87	5.92	5.98	6.03	6.09	6.14	6.20
1.08	2.91	2.94	2.97	2.99	3.02	3.05	3.08	3.10
	5.87	5.93	5.98	6.04	6.09	6.14	6.20	6.25
1.09	2.94	2.97	2.99	3.02	3.05	3.08	3.10	3.13
	5.92	5.98	6.04	6.09	6.15	6.20	6.26	6.31
1.10	2.97	2.99	3.02	3.05	3.08	3.10	3.13	3.16
	5.98	6.04	6.09	6.15	6.20	6.26	6.31	6.37
1.11	2.99	3.02	3.05	3.08	3.10	3.13	3.16	3.19
	6.03	6.09	6.15	6.20	6.26	6.32	6.37	6.43
1.12	3.02	3.05	3.08	3.10	3.13	3.16	3.19	3.22
	6.09	6.14	6.20	6.26	6.32	6.37	6.43	6.49
1.13	3.05	3.08	3.10	3.13	3.16	3.19	3.22	3.25
	6.14	6.20	6.26	6.31	6.37	6.43	6.49	6.54
1.14	3.07	3.10	3.13	3.16	3.19	3.22	3.25	3.27
	6.20	6.25	6.31	6.37	6.43	6.49	6.54	6.60
1.15	3.10	3.13	3.16	3.19	3.22	3.25	3.27	3.30
	6.25	6.31	6.37	6.43	6.48	6.54	6.60	6.66
1.16	3.13	3.16	3.19	3.22	3.24	3.27	3.30	3.33
	6.31	6.36	6.42	6.48	6.54	6.60	6.66	6.72

TABLE 6

STACKED CUBIC METRE VOLUME

1.26 AND 2.54 METRES IN LENGTH

LTH	2.14	2.16	2.18	2.20	2.22	2.24	2.26	2.28
HT								
1.17	3.15	3.18	3.21	3.24	3.27	3.30	3.33	3.36
	6.36	6.42	6.48	6.54	6.60	6.66	6.72	6.78
1.18	3.18	3.21	3.24	3.27	3.30	3.33	3.36	3.39
	6.41	6.47	6.53	6.59	6.65	6.71	6.77	6.83
1.19	3.21	3.24	3.27	3.30	3.33	3.36	3.39	3.42
	6.47	6.53	6.59	6.65	6.71	6.77	6.83	6.89
1.20	3.24	3.27	3.30	3.33	3.36	3.39	3.42	3.45
	6.52	6.58	6.64	6.71	6.77	6.83	6.89	6.95
1.21	3.26	3.29	3.32	3.35	3.38	3.42	3.45	3.48
	6.58	6.64	6.70	6.76	6.82	6.88	6.95	7.01
1.22	3.29	3.32	3.35	3.38	3.41	3.44	3.47	3.50
	6.63	6.69	6.76	6.82	6.88	6.94	7.00	7.07
1.23	3.32	3.35	3.38	3.41	3.44	3.47	3.50	3.53
	6.69	6.75	6.81	6.87	6.94	7.00	7.06	7.12
1.24	3.34	3.37	3.41	3.44	3.47	3.50	3.53	3.56
	6.74	6.80	6.87	6.93	6.99	7.06	7.12	7.18
1.25	3.37	3.40	3.43	3.47	3.50	3.53	3.56	3.59
	6.79	6.86	6.92	6.99	7.05	7.11	7.18	7.24
1.26	3.40	3.43	3.46	3.49	3.52	3.56	3.59	3.62
	6.85	6.91	6.98	7.04	7.10	7.17	7.23	7.30
1.27	3.42	3.46	3.49	3.52	3.55	3.58	3.62	3.65
	6.90	6.97	7.03	7.10	7.16	7.23	7.29	7.35
1.28	3.45	3.48	3.52	3.55	3.58	3.61	3.64	3.68
	6.96	7.02	7.09	7.15	7.22	7.28	7.35	7.41
1.29	3.48	3.51	3.54	3.58	3.61	3.64	3.67	3.71
	7.01	7.08	7.14	7.21	7.27	7.34	7.41	7.47
1.30	3.51	3.54	3.57	3.60	3.64	3.67	3.70	3.73
	7.07	7.13	7.20	7.26	7.33	7.40	7.46	7.53
1.31	3.53	3.57	3.60	3.63	3.66	3.70	3.73	3.76
	7.12	7.19	7.25	7.32	7.39	7.45	7.52	7.59
1.32	3.56	3.59	3.63	3.66	3.69	3.73	3.76	3.79
	7.17	7.24	7.31	7.38	7.44	7.51	7.58	7.64
1.33	3.59	3.62	3.65	3.69	3.72	3.75	3.79	3.82
	7.23	7.30	7.36	7.43	7.50	7.57	7.63	7.70

APPENDIX D

SUMMARY OF FORMULAE

(i) Volume in cubic metres of timber or defects up to 5.7 metres in length

$$\frac{D^2 \times 0.7854 \times L}{10,000}$$

= cubic metres correct to three decimal places

Where: D = diameter of log or defect in 2 centimetre classes
L = length of log or defect in metres and 20 centimetre classes

---

(ii) Volume in cubic metres of timber 5.9 metres in length and longer

$$\frac{MD^2 \times 0.7854 \times L}{10,000}$$

= cubic metres correct to three decimal places

Where: MD = mean diameter of log in 2 centimetre classes
L = length of log in metres and 20 centimetre classes

(iii) Volume in stacked cubic metres

H x L x W = stacked cubic metres correct to two decimal places

Where: H = height of stack in metres and 2 centimetre classes
L = length of stack in metres and 2 centimetre classes
W = width of stack (length of bolt) in metres and 2 centimetre classes

(iv) Volume in stacked cubic metres **rough** for individual logs or defects

$$\frac{(D^2 \times 0.7854 \times L)}{10,000} = \text{metres cubed correct to 3 decimals} \times 1.50$$

= stacked cubic metres correct to two decimal places

Where: D = diameter of log or defect in 2 centimetre classes
L = length of log (or width of pile) or defect in metres and 2 centimetre classes

---

(v) Volume in stacked cubic metres **peeled** for individual logs or defects

$$\frac{(D^2 \times 0.7854 \times L)}{10,000} = \text{metres cubed correct to 3 decimals} \times 1.28$$

= stacked cubic metres correct to two decimal places

Where: D = diameter of log or defect in 2 centimetre classes
L = length of log (or width of pile) centimetre or defect in metres and 2 centimetre classes

APPENDIX E

GLOSSARY OF TERMS

- ***Crown Charges*** means all prices, charges, fees, penalties, costs, expenses, interest and fines imposed under the *Crown Forest Sustainability Act (CFSA)* or under a Forest Resource Licence

- ***Forest Resource Licence*** means a licence that authorizes the harvesting of Crown forest resources under Part 111 of the *CFSA*

- ***Licensee*** means a person or company to whom a Forest Resource Licence has been granted

- ***Operating Year*** means the twelve month period commencing on the 1st day of April in any year and ending on the 31st day of March in the following year

- ***Stumpage Values*** in this manual means the fixed minimum rate plus residual value, the forest renewal charge, and forestry futures charges, including bid prices if any

- ***Timber*** in this Manual includes Crown forest resources that are fixed length, tree length and wood chip fibre

- ***Scale Records*** include but are not limited to scale tallies, delivery ledgers, summaries and statements of the amount of timber measured, purchase records and payment records

- ***Undersize*** is any material below the minimum diameters defined in the utilization standards of this Manual (Section E-Wasteful Practices). This has been implemented as a result of Item # 12, Ontario Forest Accord, 1999

APPENDIX F

REFERENCES

- *Scaling Audit Reference Manual 4th Edition. MNR. 2006*
- *Canadian Institute of Chartered Accountant's Handbook. C.I.C.A.. 1991*
- *Forest Operations and Silviculture Manual. lst Edition. MNR.1995*
- *Sampling Standards Manual, 2000*
- *Canadian Standards Association; Scaling Roundwood CAN 3-0302-1-M86*
- *Weights and Measures Act, Canada*

5430
(1.0k P.R. 19 05 07)
ISBN 0-7794-0773-3